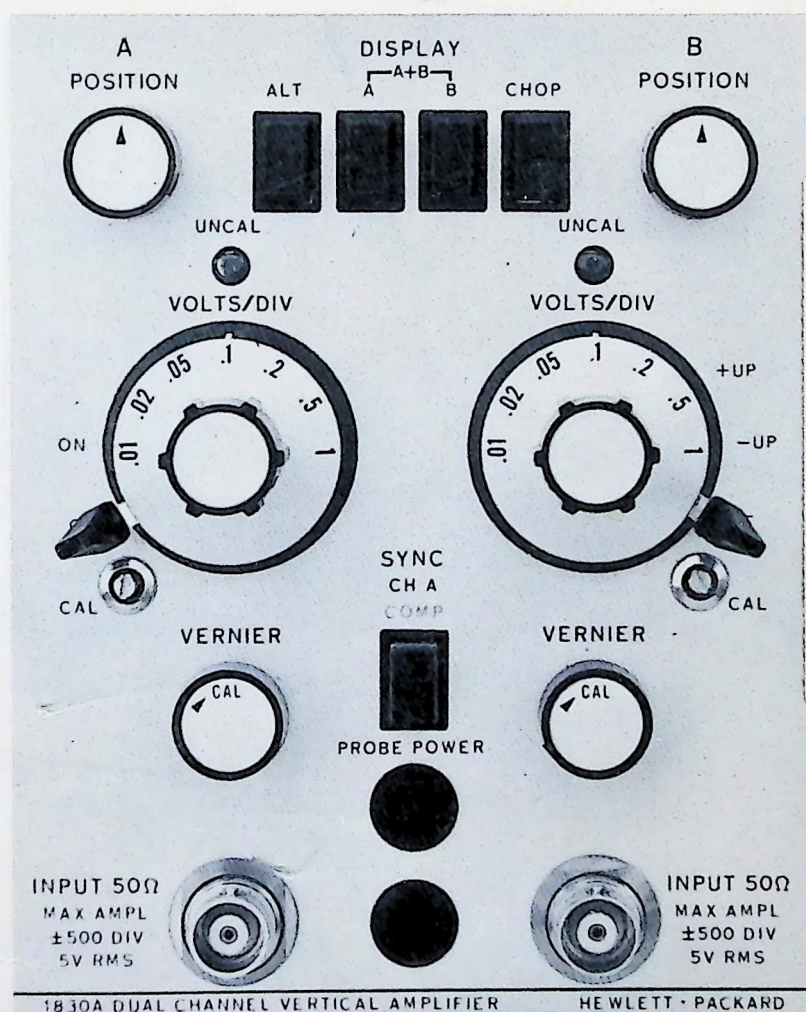


DUAL CHANNEL VERTICAL AMPLIFIER

1830A



HEWLETT  PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.



OPERATING AND SERVICE MANUAL

MODEL 1830A DUAL CHANNEL VERTICAL AMPLIFIER

SERIALS PREFIXED: 968—

Refer to Section VII for instruments with the following
serial prefix numbers: 942—, 967—.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number: 01830-90902
Microfiche Part Number: 01830-90802

PRINTED: NOV 1970

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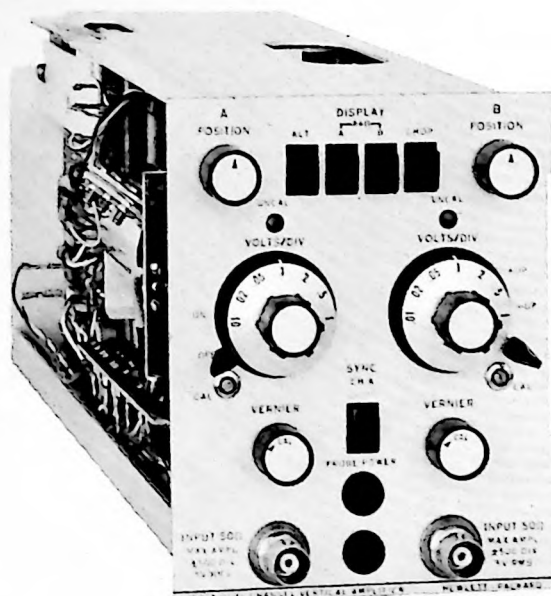


Figure 1-1. Model 1830A Dual Channel Vertical Amplifier

Table 1-1. Specifications

MODES OF OPERATION

Channel A alone; Channel B alone; Channels A and B displayed alternately on successive sweeps (ALT); Channels A and B displayed by switching (time shared) between channels (CHOP), chop frequency of 250 kHz; Channel A plus Channel B; Channel A minus Channel B.

EACH CHANNEL**BANDWIDTH**

DC to 250 MHz 3 dB down from 6 div reference signal, 50-ohm source.

RISETIME

≤ 1.5 ns. 10% to 90% with 6 div input step, 50-ohm source.

DEFLECTION FACTOR**RANGES:**

From 0.01 V/div to 1 V/div (7 positions) in 1, 2, 5 sequence. $\pm 3\%$ accuracy, calibration adjustment on front panel.

VERNIER:

Continuously variable between all ranges, extends deflection factor to 2.5 V/div., vernier UNCAL (uncalibrated) light indicates when vernier is not in the calibrated position.

POLARITY

Channel B only: +UP or -UP; selectable.

SIGNAL DELAY

> 55 ns to allow viewing the leading edge of a pulse without external delay.

INPUT CHARACTERISTICS

Reflection coefficient: (measured with 1 ns TDR risetime) $\leq 10\%$ on 10 mV/div and $\leq 5\%$ from 20 mV/div to 1.0 V/div. VSWR: ≤ 1.30 on 10 mV/div and ≤ 1.20 from 20 mV/div to 1.0 V/div.

MAXIMUM INPUT

5 volts RMS or ± 500 divisions peak, whichever is less.

SYNC

Channel A or composite (on displayed signal).

FREQUENCY

DC to > 250 MHz on signals causing 1 division or more vertical deflection in all modes.

PROBE POWER:

Provides power for operating two active probes.

DC DRIFT:

Short term drift/min and long term drift/hour ≤ 0.05 div after 1/2 hr from turn-on at constant ambient temperature.

A + B OPERATION:

Amplifier: meets independent channel specifications for risetime and bandwidth. B channel may be inverted for A-B operation.

GENERAL**WEIGHT**

Net, 5 lb (2,3 kg); shipping, 8 lb (3, 6 kg).

ENVIRONMENT

Same as Model 183A/B.

SECTION I

GENERAL INFORMATION

1-1. SCOPE OF MANUAL.

1-2. This manual contains complete operating and service information for the HP Model 1830A Dual Channel Vertical Amplifier. All aspects of the instrument are covered in eight sections, each of which can be referred to for specific data by use of the table of contents. Schematics are located at the rear of the manual on "throw-clear" pages which permit simultaneous reference to the text. All component parts are called out on conveniently located reference photographs or drawings, and a complete parts list is contained in Section VI. Detailed performance check and adjustment information is provided in Section V, and circuit operation is explained at Section IV. Supplementary operating information is contained in the Operating and Service Manuals for the HP Model 183A/B Oscilloscope mainframe and the Time Base plug-in.

1-3. INSTRUMENT DESCRIPTION.

1-4. The HP Model 1830A is a dual channel plug-in vertical amplifier (See Figure 1-1) designed to operate in conjunction with a horizontal Time Base plug-in as an integral part of the HP Model 183A/B oscilloscope mainframe. Each channel of this vertical amplifier has a bandwidth of dc to 250 MHz, and has a fixed input impedance of 50 ohms.

1-5. Two input signals can be displayed individually, alternatively, in a chopped (time shared) mode, or in an algebraically added mode ($A \pm B$). These display operating capabilities are selected by pushbutton for ease of operation. Front-panel controls are also provided for each channel to permit operator selection of display position and display deflection factor.

1-6. A choice of positive or negative polarity display of the Channel B input signal is provided, and the displayed signals may be synchronized to the Channel A input signal or the composite of the input signals.

1-7. Seven calibrated deflection factor ranges are provided for each channel. These fixed ranges have deflection factors from 0.01 volts per division to 1 volt per division, arranged in a 1, 2, 5 sequence. The instrument is designed to maintain a low VSWR on all ranges with the VSWR being 1.30 or less from dc to 250 MHz on the .01 V/div range, and 1.20 or less on the .02 to 1.0 V/div ranges.

1-8. During operation, the Model 1830A can be directly coupled (by 50-ohm coax) to examine or measure signals originating from a 50 ohm source. By using an active probe such as the HP Model 1120A or a passive probe such

as the HP Model 10020A, the instrument can be used to examine signals within an operating circuit.

1-9. INSTRUMENT IDENTIFICATION.

1-10. Hewlett-Packard uses a two section serial number for instrument identification. The serial prefix number is the first group of digits in the instrument serial number. The succeeding digits identify a particular instrument within the series. See Figure 2-2. The instrument serial number is located on a tag located on the rear panel of the instrument.

1-11. MANUAL IDENTIFICATION AND CHANGES.

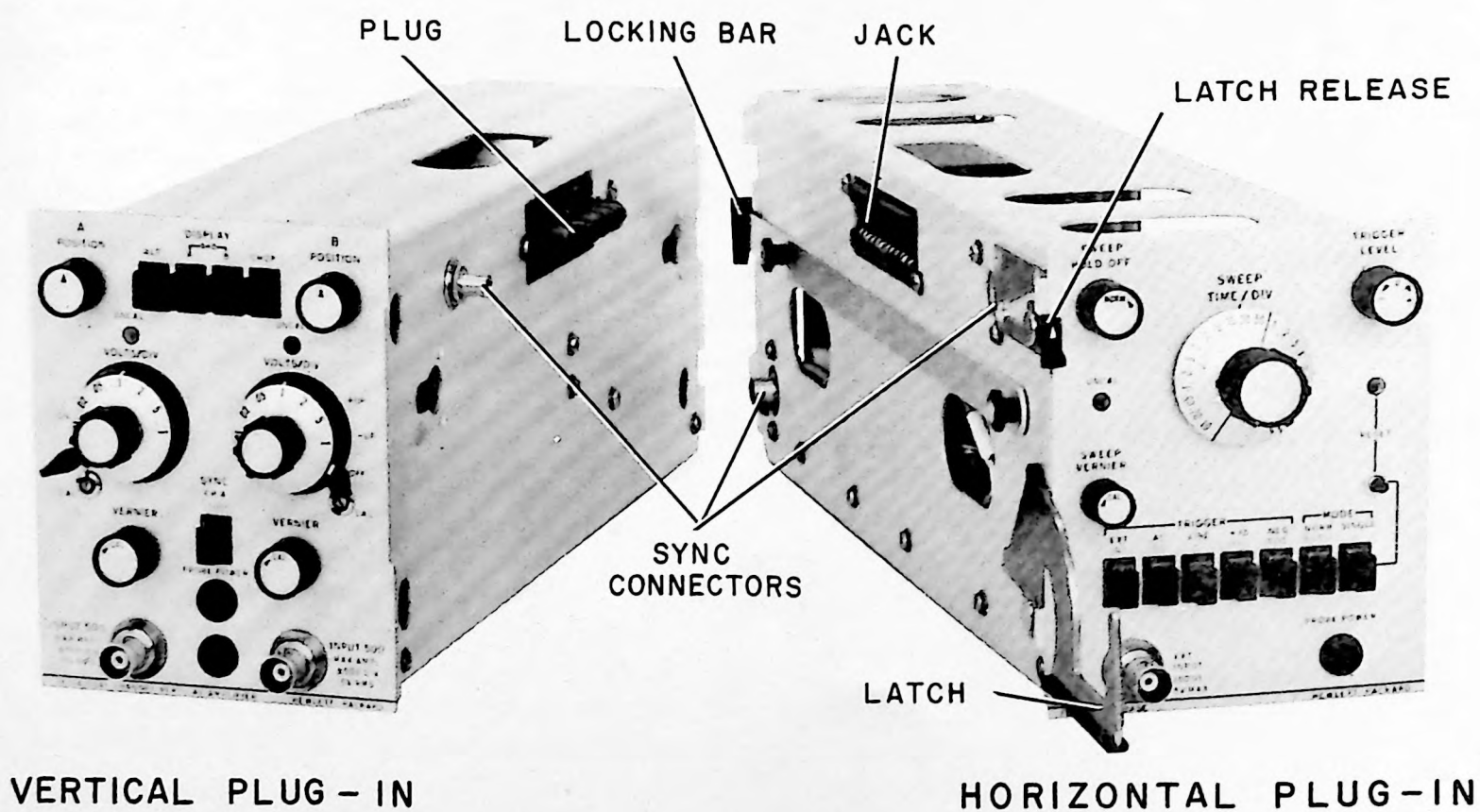
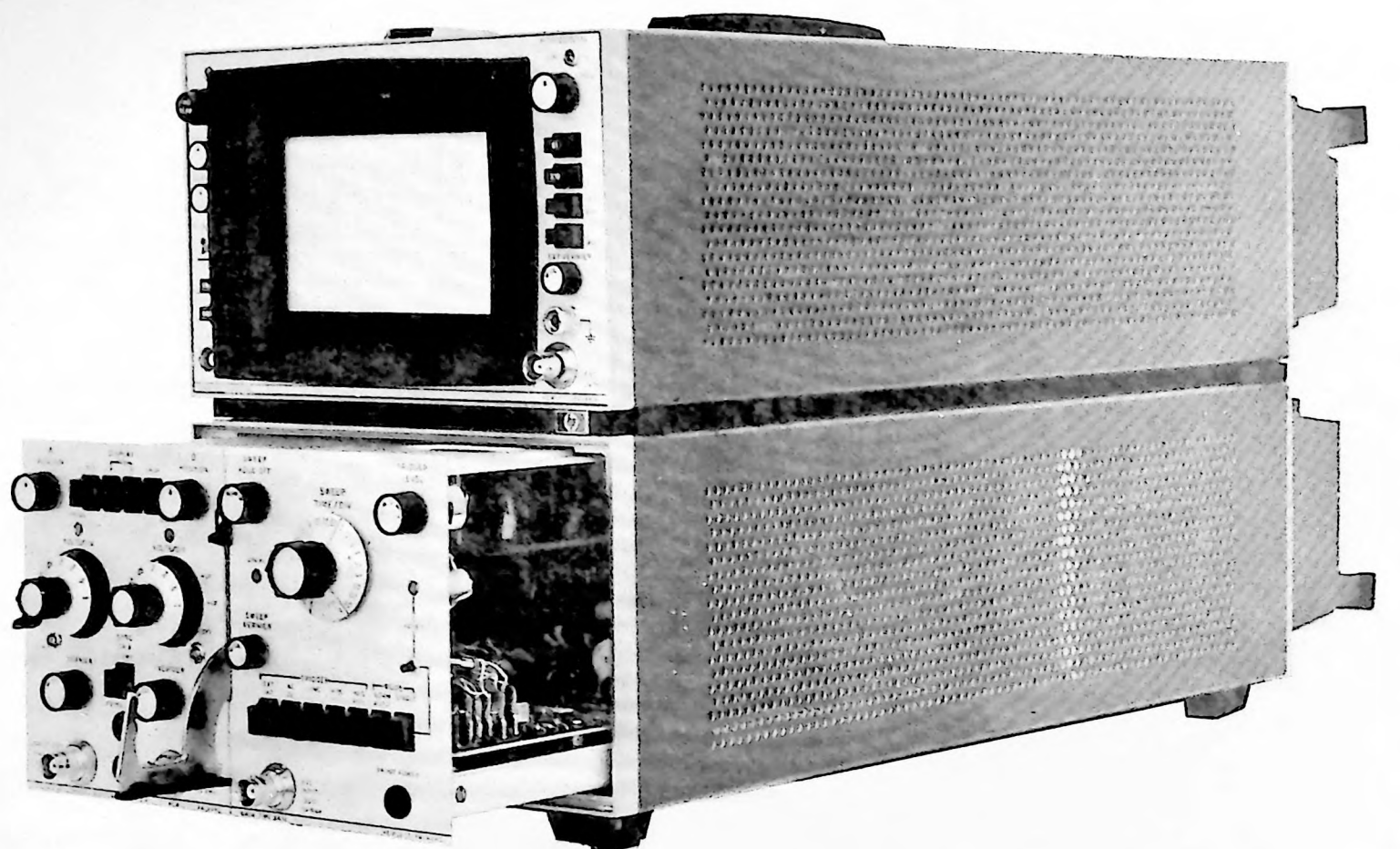
1-12. Information in this manual applies directly to instruments (as manufactured) with serial numbers prefixed by the three digits as shown on the title page. If the serial prefix of the instrument is different from that on the title page, a "Manual Changes" sheet supplied, or Section VII of this manual, will describe changes which will adapt this manual to provide correct coverage.

1-13. Technical corrections to this manual, due to known errors in print, are called "ERRATA" and are corrected on the enclosed "Manual Changes" sheet (if any). Refer any questions regarding the instrument, manual, or change sheet to the nearest HP Sales/Service Office listed at the rear of this manual. Be sure to identify the instrument by both model and complete serial number in all correspondence.

1-14. ACCESSORY PROBES.

1-15. The Model 1120A Active Probe is available for use with the Model 1830A. It is a 1:1 active probe with a 100-kilohm input impedance, shunted by less than 3 pf, having a 50-ohm output which matches the 50-ohm input of the Model 1830A. Its operating power is supplied by the Model 183A/B oscilloscope power supply via the Model 1830A, or by a separate power supply (Model 1122A). With an operating bandwidth of dc to 500 MHz, its maximum input is +100 volts with a maximum risetime of less than 0.75 ns.

1-16. The Model 10020A Resistive Divider Kit may also be used with the 1830A. It is a signal probing accessory designed for use with 50-ohm systems. The kit includes a series of dividers ranging from 1:1 to 100:1 which allow matching various source impedances. The dividers have 0.7 pf of shunt capacitance and have a minimal effect on the risetime of high-frequency signals.



VERTICAL PLUG - IN

HORIZONTAL PLUG-IN

1830A-A-17

Figure 2-1. Plug-in Mating

SECTION II

INSTALLATION

2-1. GENERAL.

2-2. This section contains inspection and installation procedures for the Model 1830A Dual Channel Vertical Amplifier. In addition, packing and claims procedures are discussed in the event damage occurs during shipment.

2-3. The instrument was carefully inspected, mechanically and electrically, prior to shipment. On receipt, inspect it for any mechanical damage which may have been incurred during transit, and test for electrical performance.

2-4. INITIAL INSPECTION.

2-5. **MECHANICAL CHECK.** Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 1830A for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to Paragraph 2-7 for the recommended claims procedure. If the instrument appears undamaged, perform the electrical check. Retain the packaging material for possible future use.

2-6. **ELECTRICAL CHECK.** The performance check is given in Section V. This check will determine whether or not the instrument is operating within specifications as listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated in the warranty on the inside front cover of this manual. If the instrument does not perform as specified, refer to Paragraph 2-7 for the recommended claims procedure.

2-7. CLAIMS.

2-8. If physical damage is found or if the instrument is not operating within the specifications when received, notify the carrier and the nearest HP Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement without waiting for a claim to be settled with the carrier.

2-9. REPACKAGING FOR SHIPMENT.

2-10. If the instrument is to be shipped to an HP Sales/Service Office for repair or service, attach a tag showing owner and owner's address, instrument model number and eight-digit serial number, and a description of the service required. Mark the shipping carton "FRAGILE" to ensure proper handling during shipment.

2-11. The original shipping carton and packaging material should be reused for shipment. If they are not available or reusable, the following material should be used:

a. A double-walled carton (refer to Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a non-abrasive material such as polyurethane or a cushioned paper around all projecting parts).

c. At least 4 inches of tightly-packed, industry-approved shock-absorbing material, such as an extra-firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of the carton.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

CAUTION

This instrument is designed to operate with the Model 183A/B Oscilloscope. Do not attempt to use it with other HP Model 180-series oscilloscopes. A mechanical interlock is provided on the associated Time Base plug-in which prevents full insertion of the mated units. Do not attempt to perform maintenance or adjustments on the Model 1830A by connecting it to one of the other HP oscilloscopes with an extender cable, since they do not supply the required operating power.

2-12. INSTALLATION.

2-13. The Model 1830A Dual Channel Vertical Amplifier is designed to mate with a Time Base plug-in unit and fit into the plug-in compartment of the Model 183A/B Oscilloscope mainframe. Figure 2-1 shows the interconnection and coupling mechanism of each plug-in unit and associated Model 183A mainframe. Power for the

Model 1830A is supplied by the oscilloscope. The following procedure explains how to install this plug-in into the oscilloscope mainframe.

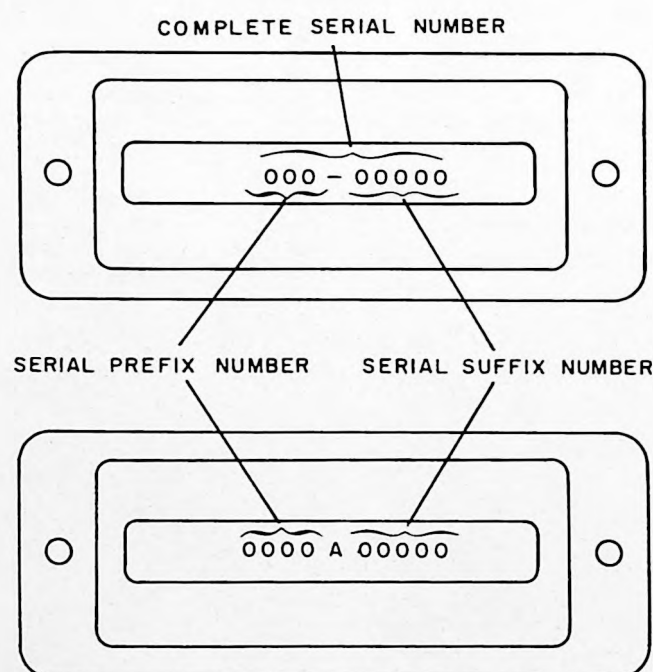
- a. Pull locking bar of Time Base plug-in to rear.
- b. Match connectors of Vertical and Time Base plug-ins and engage by pressing together. (Make sure locking bar buttons are properly positioned.)
- c. When the plug-ins are joined, press locking bar forward to lock them together.
- d. Insert plug-ins into the Model 183A/B mainframe.
- e. When the assembly is fully in, swing the latch up and snap into place. (The assembly is now locked into the mainframe and ready for use.)

Before actual use, perform the performance check procedure in Section V to insure that the instrument operates according to specifications given in Table 1-1.

2-14. REMOVAL.

2-15. To remove the plug-in units, use the following procedure:

- a. Slide the latch release upward.
- b. Rotate the plug-in latch downward.
- c. Use the latch to pull the mated plug-ins free of the mainframe.
- d. Pull the locking bar to the rear.
- e. Separate the plug-ins.



7000- A-20

Figure 2-2. Instrument Serial Number

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. Information regarding initial turn-on procedures and front panel adjustments is provided in this section to assist the operator in properly setting up and using the Model 1830A. Functions and capabilities provided by the front panel controls are explained, and operating instructions for some typical applications of the instrument are provided for the user.

3-3. FRONT PANEL CONTROLS.

3-4. All operating controls and front panel adjustments are identified and described in Figure 3-1. The information presented gives the operator a quick reference regarding the operating function of each. Additional information regarding some of these is explained below in greater detail.

3-5. **INPUTS.** The amplifier is dc coupled to the input signal. Provision is made for removing the input signal from the amplifier without the need for disconnecting the input signal cable. This is accomplished by positioning the Channel A and Channel B input switch to OFF. Switching either input to OFF will not disturb the input signal via reflections back through the input cable since each input is always terminated in 50 ohms.

3-6. **POLARITY.** The displayed signal of the channel A input is always +UP, however the displayed polarity of the channel B input signal is selectable. Either +UP or -UP display of the B channel signal may be utilized.

3-7. **VOLTS/DIV.** Seven calibrated fixed ranges of input signal attenuation are available for each channel. Attenuator sections are connected in a series combination to provide the desired attenuation while maintaining a constant 50-ohm input impedance. The ranges are in a 1, 2, 5 sequence and the deflection factors range from 0.01 volt per division to 1.0 volt per division as displayed on the CRT.

3-8. **VERNIER.** The deflection factor on any selected range of the VOLTS/DIV switch can be continuously varied to decrease the sensitivity, extending the display factor of each range by two and one-half times. The 1.0 volt range, for example, becomes extendable to at least 2.5 volts per division. When the Vernier is switched out of the calibrated (CAL) position and turned counter-clockwise, the UNCAL indicator light is illuminated to warn that the selected (calibrated) VOLTS/DIV range is no longer directly applicable to the display.

3-9. **SYNC.** When it is desired to use the input signal as the source for generating a trigger for the horizontal sweep, this control provides for operator selection of the signal to be utilized. Either the signal in Channel A or the composite signal may be used as the sync source. If the Channel A input switch is OFF, the Channel B signal may be used by placing the SYNC switch in the COMP position. Any signal from dc to at least 250 MHz which will result in a CRT display of 1 division or more of vertical deflection will provide a stable display.

3-10. **DISPLAY.** Five display modes are available by pushbutton selection: either channel A or channel B input signals may be independently displayed, the algebraic sum of the A and B signals ($A + B$ or $A - B$), and two modes for simultaneously displaying both channels (ALT and CHOP). These modes have particular application in best displaying signals of certain characteristics or under various conditions of horizontal sweep speeds. The following explanation will assist the operator in obtaining maximum initial use of the available modes.

a. When $A + B$ or $A - B$ operation is selected, the input signals of both channels are algebraically added and the display consists of the resultant value.

b. Use of the alternate mode (ALT) results in a switching between channels after each CRT sweep, thus alternately displaying the Channel A and Channel B signals on successive sweeps. This results in displaying the signal from one channel for one full sweep followed by display of the other channel's signal for a full sweep. Slow sweep speeds will result in a flickering display and therefore ALT is recommended for use at sweep speeds faster than 1 MSEC/DIV.

c. When CHOP is employed, the Channel A and the Channel B signals are keyed on and off at a rate of approximately 250 kHz. This results in a portion of the Channel A signal, for example, being displayed, followed by a portion of the Channel B signal, etc.

3-11. FRONT PANEL ADJUSTMENTS.

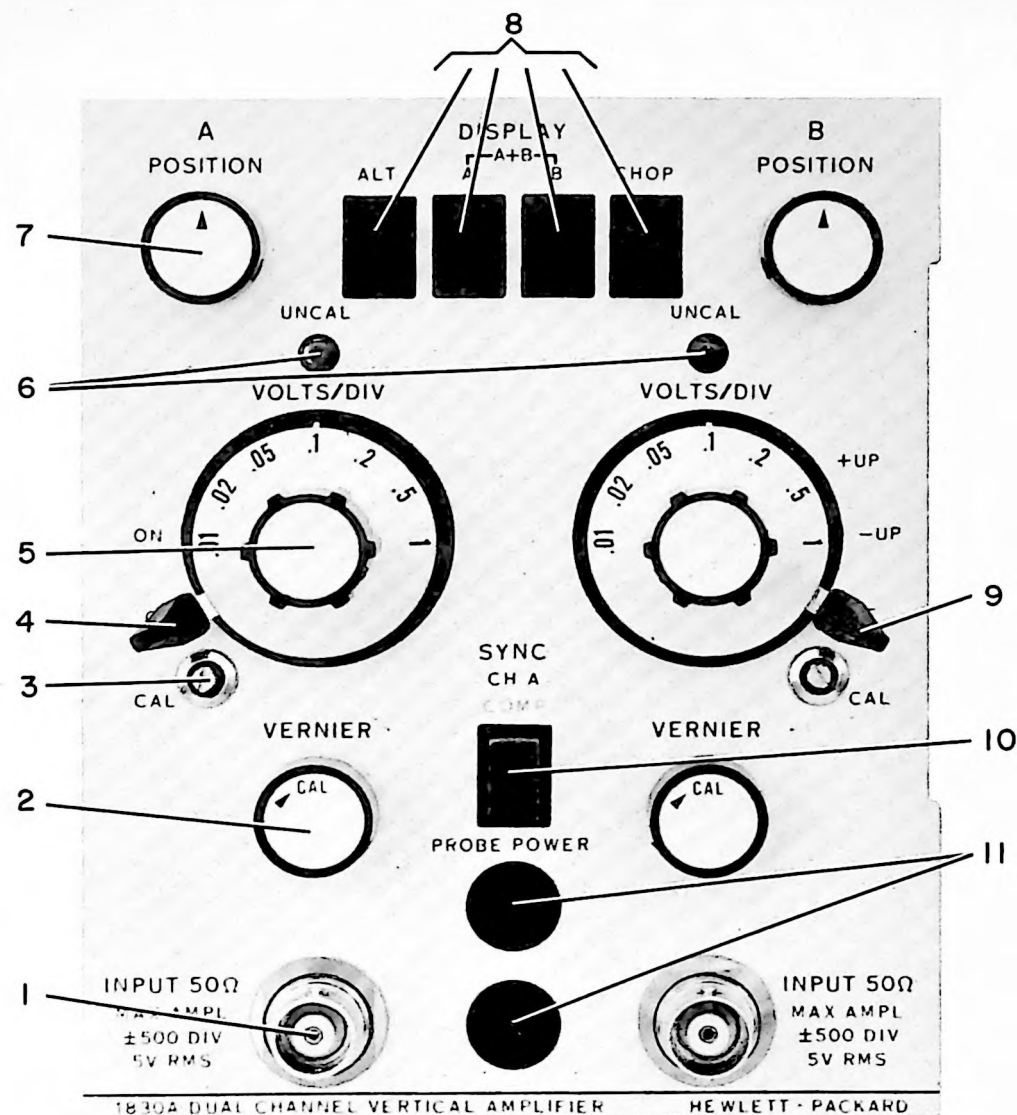
3-12. A screwdriver front panel calibration adjustment is provided for each channel. This permits setting the gain of the vertical plug-in to allow for the possible variation in CRT deflection with different mainframes. Each Model 1830A is calibrated at the factory prior to shipment. However it should be checked when first installed and when shifted between oscilloscopes. The procedure for accomplishing this is given in Figure 3-3.

3-13. OPERATING PROCEDURES.

3-14. The figures which follow are presented for the purpose of familiarizing the operator with initial turn-on and operating procedures for the modes of operation which can be used with the Model 1830A Vertical Amplifier. These step by step procedures are keyed to photographs with the various controls indexed to the procedure for rapid reference. Follow the initial turn-on procedure before operating the instrument. Then perform the initial calibration check. This will ensure that the instrument is properly adjusted and ready to be used for calibrated measurements. These operating procedures are designed to assist the operator in obtaining instrument operation and performance when employed for typical

uses and measurement requirements. Many variations in capability can be utilized based on the procedures provided.

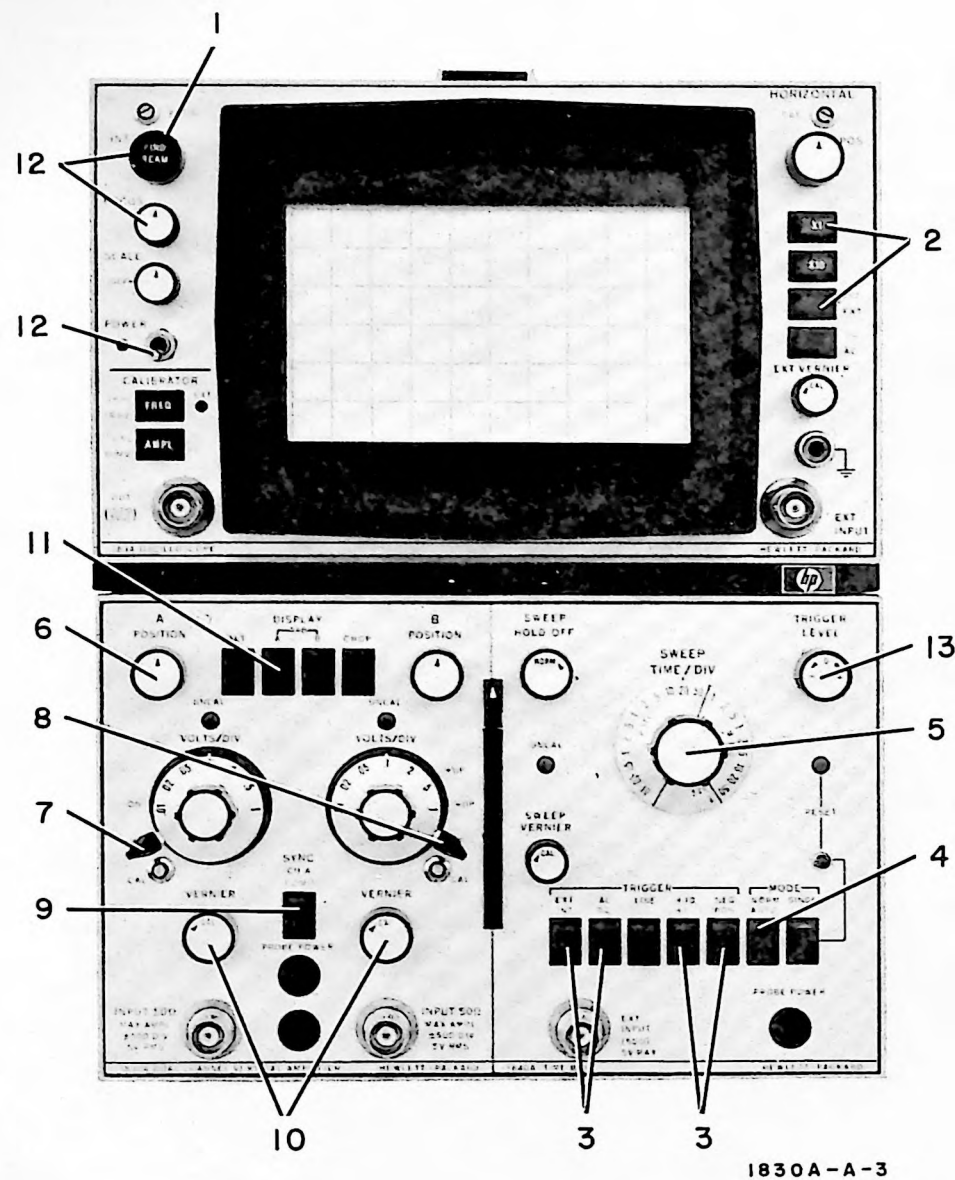
3-15. It is assumed that the operator is familiar with the related operating information for the Oscilloscope mainframe and the horizontal Time Base. The Operating and Service Manuals for these instruments also contain detailed information on installation and operation. Where necessary, the basic control positions or adjustments to these instruments which are necessary to achieve the desired operation are included in the procedures. Refer to the Oscilloscope and Time Base manuals for more detailed explanation, if required.



1830A-A-1

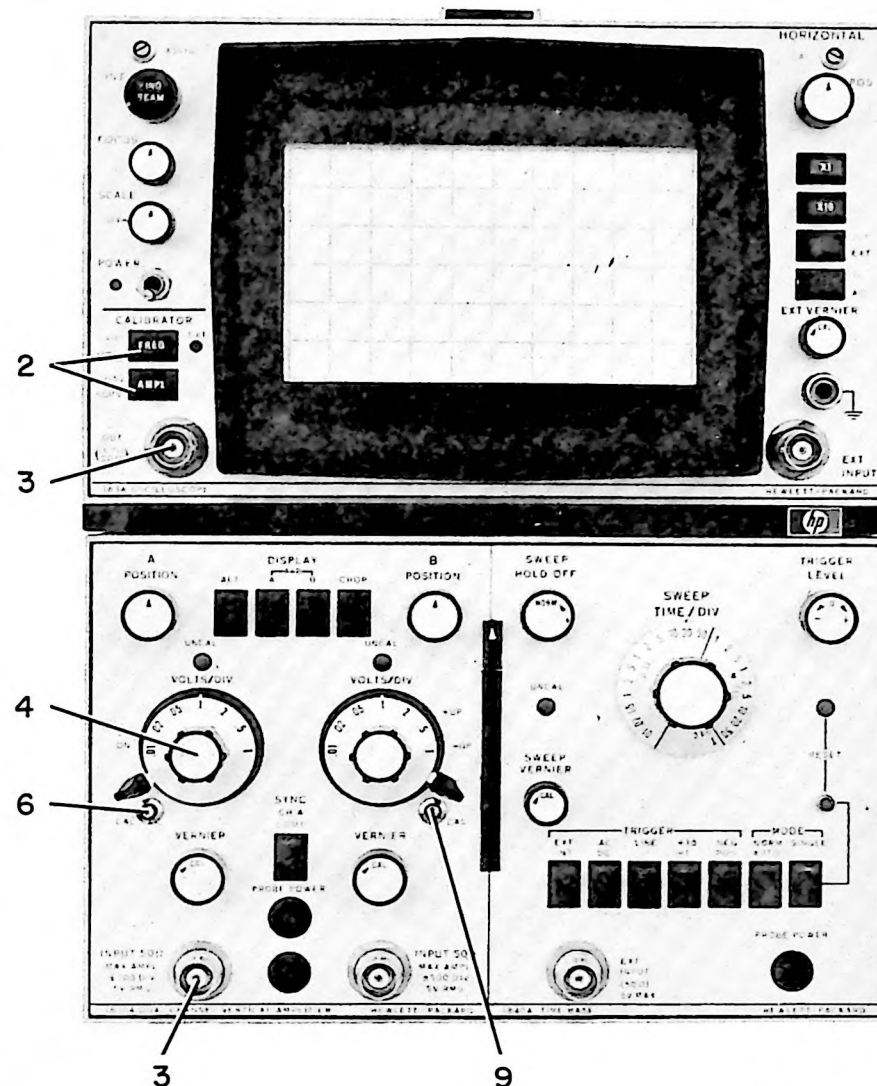
1. INPUT: Signal input connector.
2. VERNIER: Provides continuously variable selection of deflection factor between calibrated positions of the VOLTS/DIV control.
3. CAL: Adjustment to calibrate amplifier with VOLTS/DIV control.
4. On-off switch for Channel A.
5. VOLTS/DIV: Selects attenuation required to provide indicated vertical deflection factor.
6. UNCAL: Lights when VERNIER control is not in CAL detent position, indicating that deflection factor differs from VOLTS/DIV setting.
7. POSITION: Adjusts vertical position of display.
8. DISPLAY: Pushbutton selection of desired operating mode.
9. Polarity selection and off switch for Channel B.
10. SYNC: Allows choice of sync signal to be supplied to Time Base plug-in.
11. PROBE POWER: Connectors for supplying power to active probes (if used).

Figure 3-1. Controls and Connectors.



1. Set Oscilloscope intensity fully counterclockwise.
2. Set Oscilloscope HORIZONTAL controls to INT and X1.
3. Set Time Base TRIGGER controls to INT, AC, $\div 1$ and POS.
4. Set Time Base MODE to AUTO.
5. Set Time Base SWEEP TIME/DIV to .1 MSEC.
6. Set Channel A and B POSITION controls to mid-range.
7. Set Channel A ON-OFF switch to ON.
8. Set Channel B polarity to +UP.
9. Set SYNC to CH A.
10. Set both VERNIER controls to CAL.
11. Set DISPLAY to A.
12. Apply power to the Oscilloscope. Adjust INT and FOCUS for a sharp and clearly visible trace.
13. Adjust the Time Base TRIGGER LEVEL for a stable display if necessary.

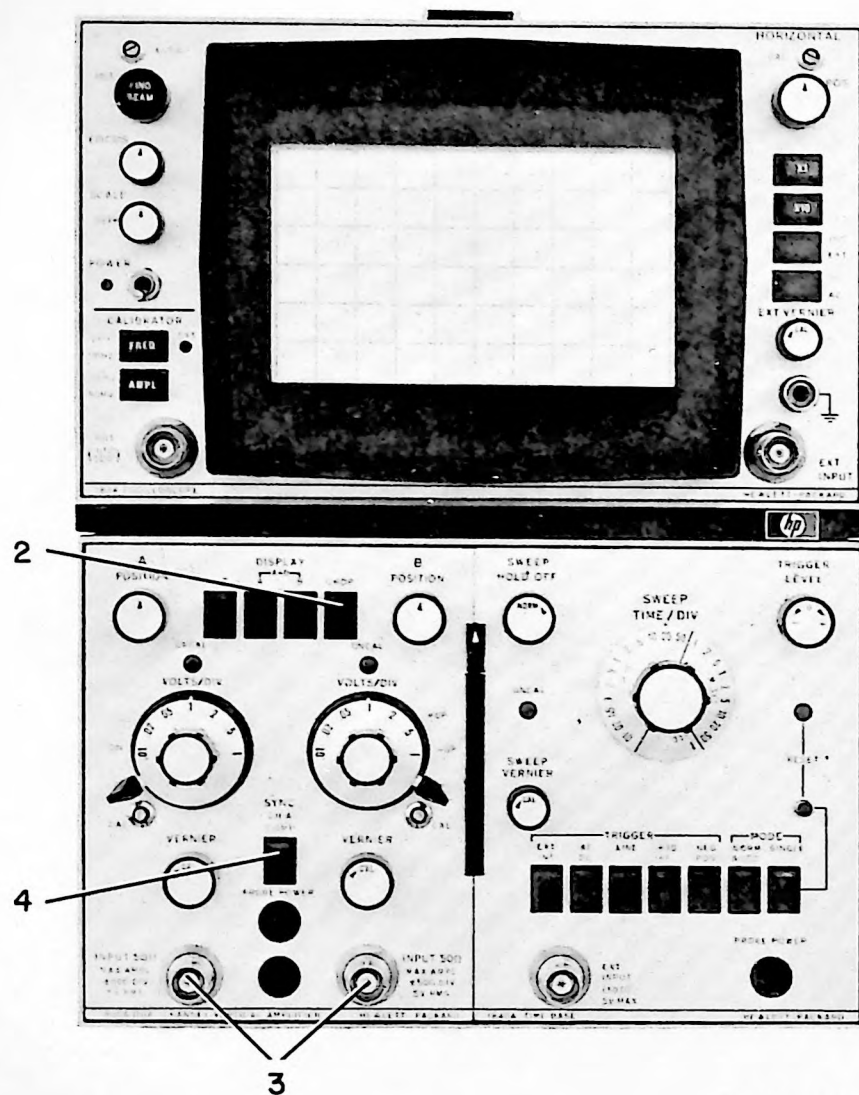
Figure 3-2. Initial Turn On Procedure.



1830A-A-4

1. Perform the initial turn-on procedure given in Figure 3-2.
2. Set Oscilloscope CALIBRATOR FREQ to 2 KHz and AMPL to 0.5V
3. Connect short 50-ohm cable from Oscilloscope CALIBRATOR OUT to Channel A INPUT.
4. Set VOLTS/DIV to 0.1.
5. Observe 5 divisions of vertical deflection. NOTE: The calibrator output signal is a negative-going pulse.
6. If necessary, adjust the Channel A CAL screwdriver control to obtain exactly 5 divisions of deflection.
7. Repeat the operation for Channel B, changing DISPLAY to B and SYNC to COMP.
8. Connect CALIBRATOR OUT to Channel B INPUT.
9. If necessary, adjust Channel B CAL screwdriver control to obtain exactly 5 divisions of vertical deflection.

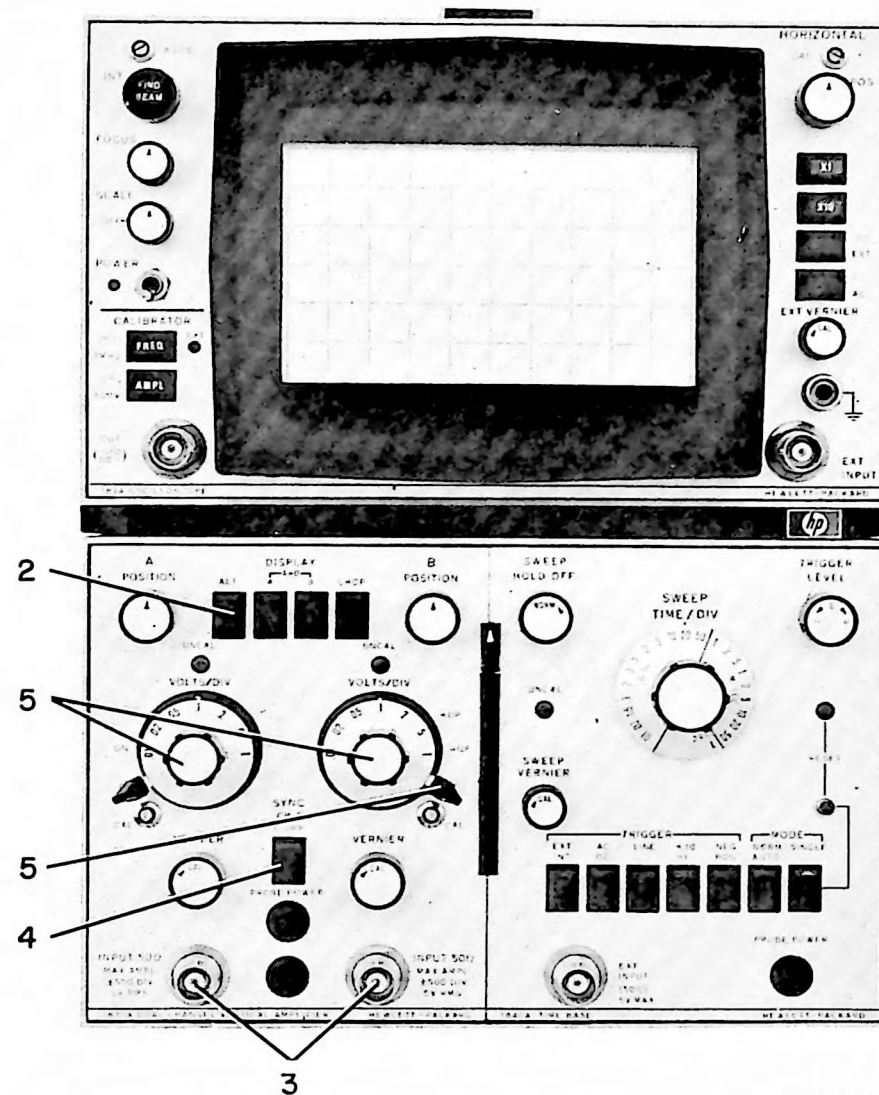
Figure 3-3. Amplifier Calibration.



1830A-A-5

1. Perform the initial turn-on procedure given in Figure 3-2.
2. Set DISPLAY to CHOP. During CHOP operation two signals can be observed simultaneously on a time sharing basis.
3. Apply the desired signals to the INPUT of both channels.
4. Set SYNC to CH A.
5. Set Channel B polarity, A and B VOLTS/DIV, POSITION and Time Base controls as required.

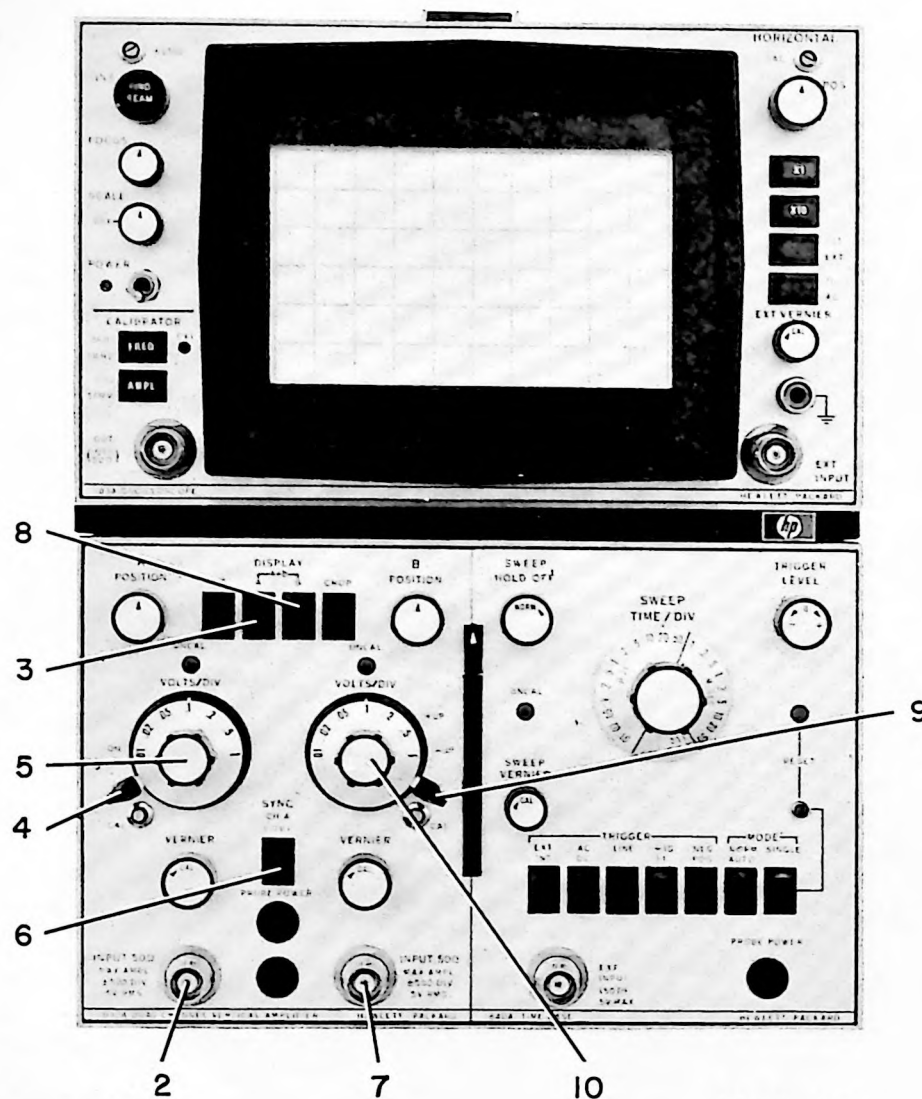
Figure 3-4. Chop Mode Operation



1830A-A-6

1. Perform the initial turn-on procedure given in Figure 3-2.
2. Set DISPLAY to ALT. During ALT operation two signals can be observed, since the signal to be displayed is alternately obtained from each Channel. The use of sweep speeds faster than 1 MSEC/DIV is preferred during ALT operation. Slower sweep speeds may result in an objectionable flicker.
3. Apply the desired signals to the INPUT of both Channels.
4. Set SYNC to COMP for display of two signals which are not time related.
5. Set VOLTS/DIV, Channel B polarity and Time Base controls as required.

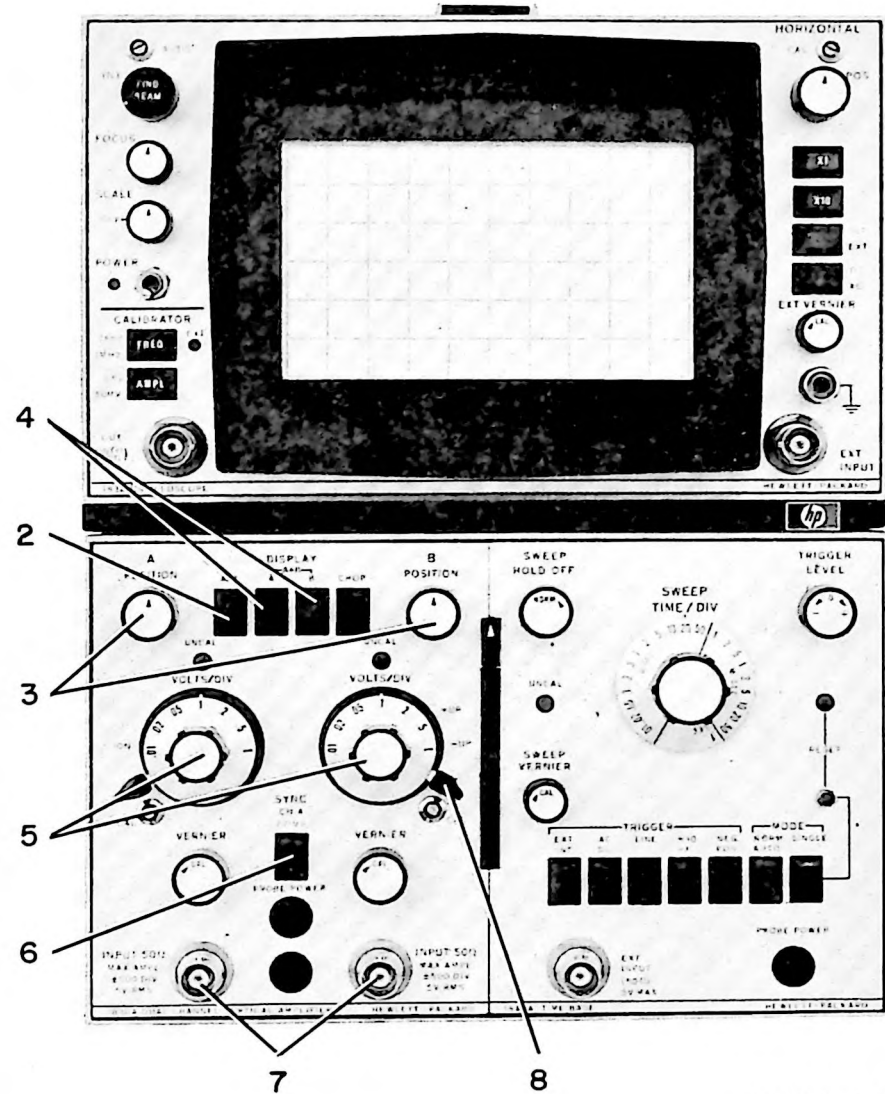
Figure 3-5. Alternate Mode Operation



1830A-A-7

1. Perform the initial turn-on procedure given in Figure 3-2.
2. Connect the desired input signal to Channel A INPUT.
3. Set DISPLAY to A.
4. Set Channel A OFF-ON switch to ON.
5. Set VOLTS/DIV and Time Base controls as required.
6. Set SYNC to CH A.
7. For Channel B operation, connect input signal to B INPUT.
8. Set DISPLAY to B.
9. Set Channel B Polarity to +UP or -UP as desired.
10. Set VOLTS/DIV and Time Base controls as required.
11. Set SYNC to COMP.

Figure 3-6. Single Channel Operation (A or B)



1830A-A-8

1. Perform the initial turn-on procedure given in Figure 3-2.
2. Set DISPLAY to ALT.
3. Position traces on center horizontal graticule line, adjusting the time base TRIGGER LEVEL if necessary.
4. Set DISPLAY to A + B.
5. Set both VOLTS/DIV controls to equal deflection factors.
6. Set SYNC to CH A or COMP as desired.
7. Connect the desired input signals to Channel A and Channel B INPUT.
8. If A-B operation is desired, set Channel B polarity to -UP.

Figure 3-7. A+B and A-B Operation

3-16. MAXIMUM SIGNAL INPUT CAPABILITY.**3-17. GENERAL.**

3-18. The instrument will accept, without damage, input signals which result in not more than ± 500 divisions of deflection, or signals having an input power of 1/2 watt into 50 ohms (this corresponds to a 5-volt RMS signal), whichever is less.

3-19. Under certain conditions it is possible to apply an input of greater than 5 volts peak for a short time. This is desirable for some measurement applications where the input signal is a pulse or complex waveform. This will usually result in an off-screen display during that time, but the excellent recovery characteristics of the amplifier can allow the observation of a signal having considerably lesser amplitude occurring shortly afterwards. Similarly, a smaller amplitude signal occurring prior to one of greater than 5 volts could also be observed.

3-20. The power rating of the resistors used in the attenuator and input termination allows the application of one-half watt continuous power input without damage. It is this power handling capability which results in an input capability of 5 volts RMS into 50 ohms. Before applying any signal having a peak amplitude greater than 5 volts, the operator must clearly understand the limits which apply. The basis of these limitations, and information regarding the calculation of the thermal equivalent circuit for the attenuator will be useful for the determination of the power input limits if it is desired to examine a signal with a peak input voltage greater than 5 volts.



The voltage and power limitations can not be modified by the variable setting factor of the VERNIER control or the CAL front panel adjustment. These controls do not affect the voltage appearing at the input to the preamplifier or the power dissipated in the attenuator.

3-21. PREAMPLIFIER INPUT LIMITS.

3-22. The input stage of the preamplifier will safely withstand a peak voltage of ± 5 volts. On the .01 VOLTS/DIV range, the input stage is directly connected to the front panel INPUT terminal. Therefore peak voltages of no more than ± 5 volts may be applied when operating in this attenuator position. On the other ranges of the VOLTS/DIV attenuator, the applied input signal is divided down, and voltages higher than ± 5 volts may be applied without exceeding the ± 5 -volt maximum input limit of the preamplifier if the one-half watt power dissipation limit is not exceeded. The limit which indicates the maximum safe input voltage which may be applied is therefore expressed as ± 500 divisions of deflection. Thus, at .01 VOLTS/DIV no more than $(\pm 500 \times .01)$ or ± 5 volts peak may be applied, while the .02 VOLTS/DIV range permits that no more than $(\pm 500 \times .02)$ or ± 10 volts may be applied. At all settings of the VOLTS/DIV control the maximum power input must be limited to one-half watt to prevent damage to the attenuator or termination resistors.

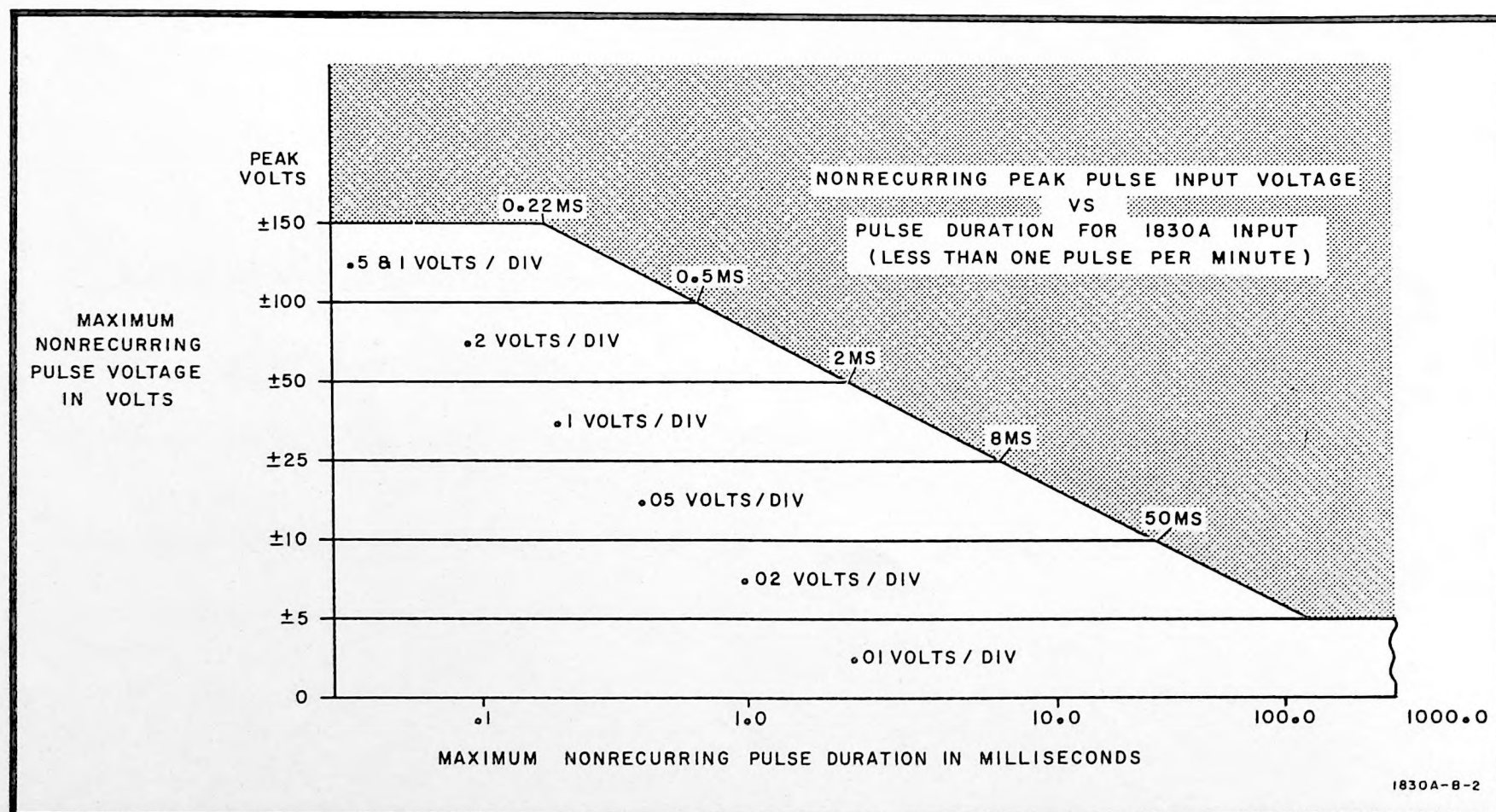


Figure 3-8. Maximum Input, Nonrecurring Signal

3-23. ATTENUATOR INPUT LIMITS.

3-24. The maximum input voltage which may be applied without damaging the resistors used in the attenuator is ± 150 volts. Therefore, the maximum peak voltage on the .5 and 1 VOLTS/DIV ranges must be limited to ± 150 volts even though this does not result in voltages which approach the ± 5 volts preamplifier input limitation.

3-25. MAXIMUM PEAK POWER.

3-26. The application of more than 5 volts peak to the INPUT of the 1830A requires that the peak power dissipation of the attenuator or internal termination resistors exceed their continuous operating rating of 1/2 watt. Therefore it is necessary to also place a time limit on the duration of the overload to prevent overheating of these components which would alter their rated value and other characteristics.

3-27. The chart of Figure 3-8 provides a rapid reference for determining the maximum peak pulse voltage which can safely be input for pulses with a recurrence rate of less than 1 per minute. For signals having an average power not exceeding 1/4 watt with a pulse recurrence rate greater than 1 per minute, the peak pulse voltage limit is given in Figure 3-9. The information which follows explains how to determine the maximum parameters of a signal which can safely be input to the Model 1830A. The basis for these limits is explained and several examples are included to illustrate the use of the applicable formula.

3-28. INPUT CAPABILITY ANALYSIS.

3-29. ATTENUATOR TEMPERATURE RISE.

3-30. If it is desired to apply a complex voltage waveform to the Model 1830A whose peak voltage exceeds 5 volts, an analysis of the thermal response of the attenuator resistors to the input signal is required to determine the surface temperature rise (T_A) to that power spectrum. If the peak temperature rise of the resistors does not exceed 30°C , the attenuator will not be damaged. The thermal equivalent circuit of the 1830A attenuator is shown in Figure 3-10.

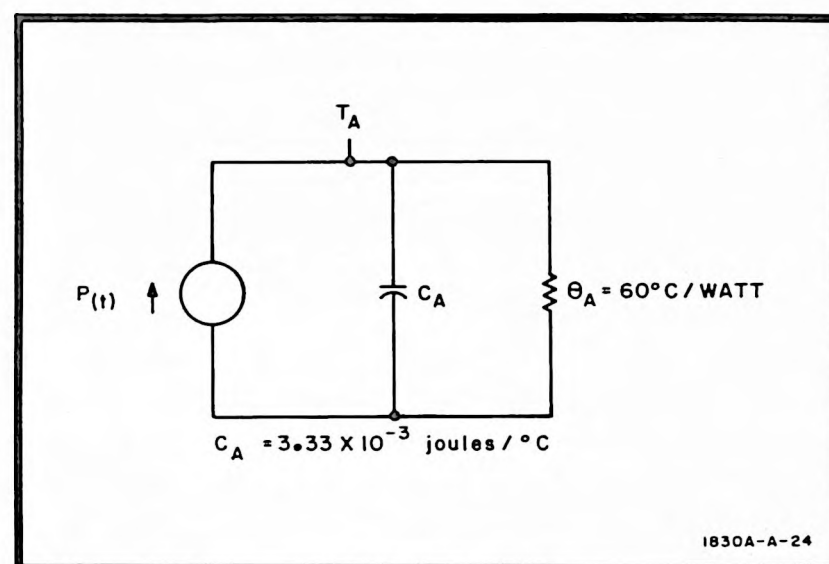


Figure 3-10. Thermal Equivalent Circuit

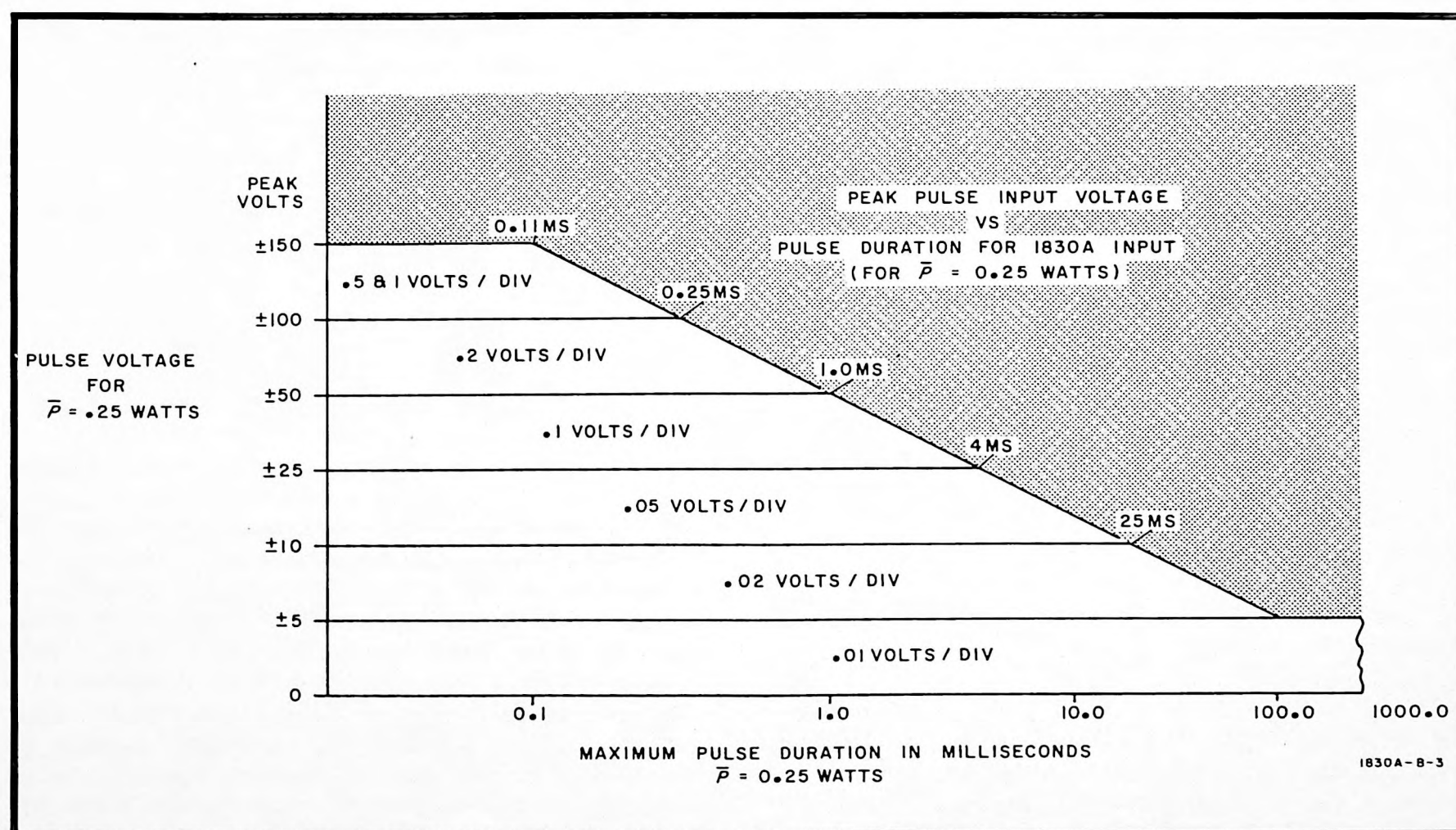


Figure 3-9. Peak Pulse Input ($\bar{P} = 0.25$ watts)

(P_t) is the instantaneous power input, in watts, to the input terminal $\left(\frac{E^2}{50}\right)$

C_A is the thermal capacity of the attenuator resistors in joules/degree C.

Θ_A is the thermal resistance of the attenuator resistors in degrees C.

3-31. Analysis of the circuit is simplified by considering the following analogy between this circuit (Figure 3-10) and an electrical circuit.

$P(t)$ is analogous to an electrical current source.

T_A is analogous to voltage.

C_A is analogous to capacitance.

Θ_A is analogous to voltage.

As an example, if a pulse of peak value P_p watts ($= V_p^2/50$) of duration T seconds having an average power input of P watts is applied, the attenuator will not be damaged if the following inequality is satisfied:

$$(1) \quad P_p \leq C_A (T_A \text{ max} - \bar{P} \Theta_A) \\ \leq .1 - .2 \bar{P}$$

If the input pulse recurs F times per second, then:

$$(2) \quad P_p T \leq \frac{.1}{1 + .2F}$$

3-32. Additional insight to determination of the instrument capability is offered by the following approach.

When the input signal is nonrecurring, (ie: $F=0$) has a pulse power input of magnitude P_p and duration T , then inequality (2) reduces to:

$$(3) \quad P_p T \leq .1 \text{ if } F \ll .2$$

3-33. All of the input limits discussed above must be applied simultaneously to avoid exceeding the attenuator or preamplifier power and voltage capability. The limits are plotted in Figure 3-8 for a nonrecurring pulse (inequality (1), $F \ll .2$) for all VOLTS/DIV settings. This shows the permitted relationships between peak amplitude input voltage and pulse duration for each attenuator range. Shown in Figure 3-9 is the peak amplitude input voltage and pulse duration which can be safely input when $\bar{P}_A = .25$ watts, and is derived from inequality (1). This assumes that the input signal has a dc level which results in an average dissipation of 1/4 watt.

3-34. TYPICAL INPUT SIGNAL CALCULATIONS.

3-35. Several examples are provided. They include an explanation of the applicable factors to be used in determining the capability of the instrument to safely accept signals greater than 5 volts and 1/2 watt.

3-36. EXAMPLE 1.

3-37. PROBLEM: Determine the maximum amplitude signal which can be input, and the deflection factor ranges which can safely be used.

ASSUME: An input pulse having a duration of 10^{-3} seconds (one millisecond) occurring at 0.5 second intervals ($F = 2 \text{ Hz}$).

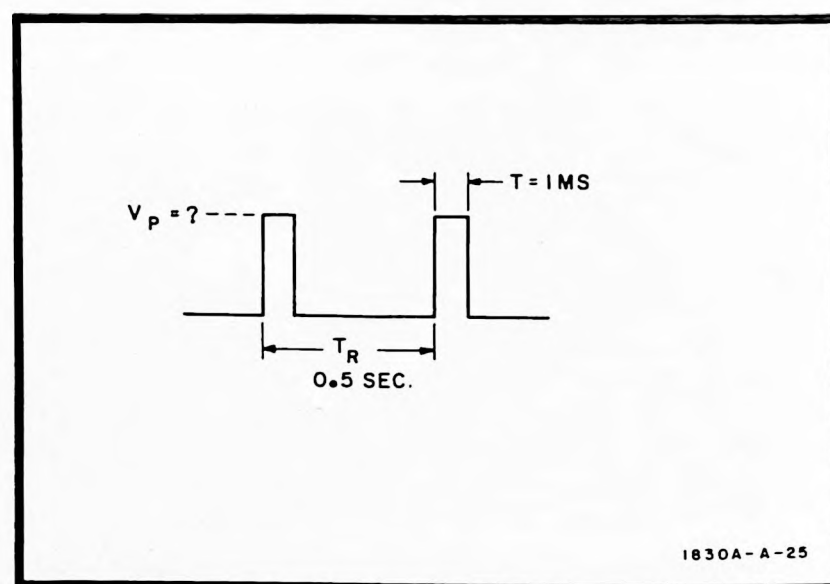


Figure 3-11. Peak Voltage Capability

Equation (2) should be used, which becomes:

$$P_p (10^{-3}) \leq \frac{.1}{1 + (.2)(2)} = .0714$$

Then $P_p \leq 71.4$ watts

$$V_p \leq \sqrt{P_p R} = \sqrt{(71.4)(50)} = 59.7 \text{ volts.}$$

The pulse will not damage the attenuator if it is less than 59.7 volts amplitude, since this maximum amplitude satisfies inequality (2) and does not exceed 150 volts. The rated input limit of 500 divisions of deflection must also be considered. If, for example, the input pulse had an amplitude of approximately 60 volts, some part of the pulse could be observed on the 0.2, 0.5 or 1 VOLTS/DIV ranges, but not on any other range without exceeding the 500 division limit. Use of the 0.1 VOLTS/DIV range would result in exceeding the rated 500 divisions of deflection ($\frac{60}{.1} = 600 \text{ div}$). The maximum deflection factor which can safely be used is: $\frac{60}{.2} = 300 \text{ div}$. The .2 VOLTS/DIV range the most sensitive which can be used without exceeding the rated input.

3-38. EXAMPLE 2.

3-39. Problem: Determine the maximum pulse duration which can be input and the deflection factor ranges which can be used.

Assume: An input signal having a continuous dc level of 3 volts with a 100 volt pulse peak occurring once per minute.

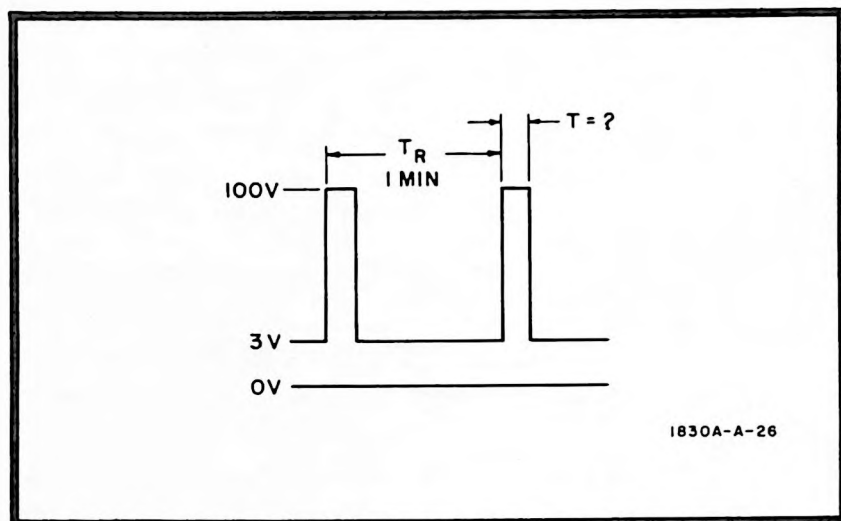


Figure 3-12. Maximum Pulse Width

Equation (1) can be used because the average power of the pulse is small due to the low repetition rate.

$$\bar{P} = \frac{(3)^2}{50} = .18 \text{ watts}$$

$$P_P = \frac{(100)^2}{50} = 200 \text{ watts}$$

Inequality (1) then becomes:

$$(200) T \leq .1 - .2 (.18) = .064$$

$$T \leq 0.32 \text{ milliseconds}$$

If the width of this pulse is less than .32 milliseconds the attenuator will not be damaged. The peak input amplitude is 100 volts. To determine the greatest deflection factor range which can safely be used:

$$\frac{100}{500} = .2 \text{ VOLTS/DIV}$$

The pulse can be safely viewed on either the .2, .5, or 1 VOLTS/DIV range.

3-40. EXAMPLE 3.

3-41. Problem: Determine the maximum deflection factor range which can be used to display a small amplitude signal in the presence of a large amplitude signal, or a multipulse signal.

Assume: Three input pulses of the amplitude, duration and spacing as shown. The pulse train is non-recurring, and it is desired to display and photograph the lesser amplitude (500 mV) pulse.

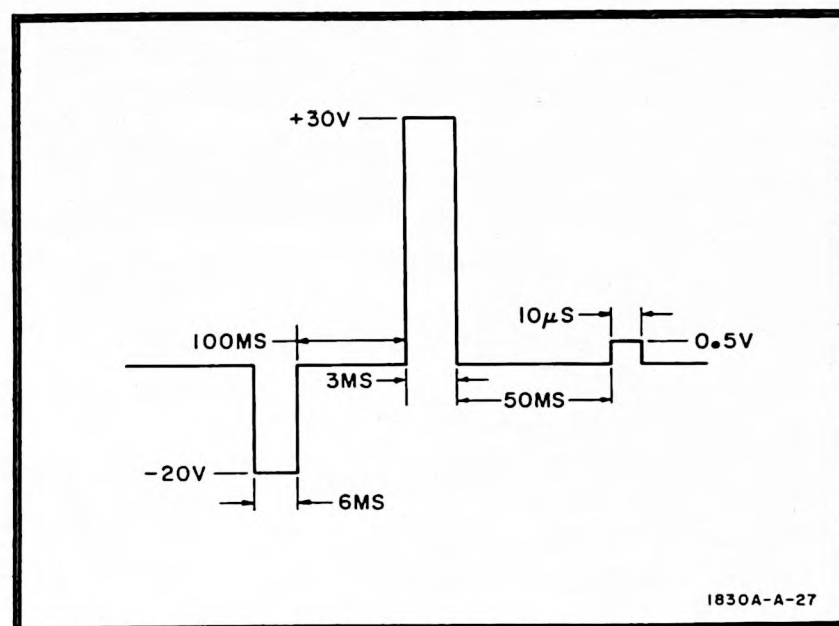


Figure 3-13. Multipulse Signals

First determine if the attenuator can safely absorb the total peak power of the pulse train. Each pulse will contribute to the peak temperature rise, with the total temperature increase dependent upon the time between pulses while the heat is dissipated. The thermal equivalent circuit of Figure 3-10 is applicable.

The increase in surface temperature (T_a), of the attenuator resistors caused by the first pulse is approximately given by the following:

$$T_A = \frac{1}{C_A} \int P(t) dt = \frac{P_{P1} T_1}{C_A}$$

$$T_a = \frac{(-20)^2 (6 \times 10^{-3})}{50 (3.33 \times 10^{-3})} = 14.4^\circ \text{C}$$

At the end of the first pulse the surface temperature of the resistors will have increased by 14.4°C . The temperature will then decrease exponentially in accordance with the following:

$$T_b = T_a e^{\left(-\frac{T_2}{\Theta_A C_A}\right)}$$

$$T_b = 14.4 e^{\left(-\frac{.1}{(60)(3.33 \times 10^{-3})}\right)}$$

$$T_b = 14.4 e^{-.5} = (14.4)(.604) = 8.7^\circ\text{C}$$

The net resistor surface temperature rise will be 8.7°C at the start of the second pulse. The temperature rise (T_c) caused by the second pulse is:

$$T_c = \frac{P_{P2} T_3}{C_A}$$

$$T_c = \frac{(30)^2}{50} \frac{(3.0 \times 10^{-3})}{(3.33 \times 10^{-3})} = 16.2^\circ\text{C}$$

The rise in resistor temperature at the end of the second pulse will be:

$$T_b + T_c = 8.7^\circ\text{C} + 16.2^\circ\text{C} = 24.9^\circ\text{C}$$

Calculation of the temperature decrease occurring between the end of the second pulse and the start of the third pulse, and the temperature increase caused by the third pulse will reveal, for this example, that the maximum temperature rise is 24.9°C . Since this is less than the maximum allowable rise of 30°C this pulse train will not damage the attenuator.

The most sensitive deflection factor range which can safely be used is determined by the largest peak amplitude pulse of the pulse train: 30 volts. This pulse cannot be permitted to result in more than 500 divisions of deflection.

$$\frac{30}{500} = .06 \text{ VOLTS/DIV}$$

Therefore the .01, .02 and .05 VOLTS/DIV ranges cannot be used since they would result in exceeding the 500 division limit. The .1, .2, .5 and 1 VOLTS/DIV ranges can be used for display of the pulse train.

Table 4-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS							
A	= assembly	E	= misc. electrical part	P	= plug	U	= integrated circuit (unrepairable)
AT	= attenuator, resistive termination	F	= fuse	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor, fan	FL	= filter	Q	= transistor	VR	= voltage regulator (diode)
BT	= battery	H	= hardware	R	= resistor	W	= cable
C	= capacitor	J	= Jack	RT	= thermistor	X	= socket
CP	= coupling	K	= relay	S	= switch	Y	= crystal
CR	= diode	L	= inductor	T	= transformer	Z	= network
DL	= delay line	LS	= speaker	TB	= terminal board		
DS	= device signaling (lamp)	M	= meter	TP	= test point		
		MP	= mechanical part				

ABBREVIATIONS							
A	= ampere(s)	FET	= field-effect transistor(s)	n	= nano (10^{-9})	rfi	= radio frequency interference
ampl	= amplifier(s)			nc	= normally closed	rms	= root mean square
assy	= assembly			no.	= normally open	rwv	= reverse working voltage
ampltd	= amplitude			npn	= negative-positive-negative		
bd	= board(s)	G	= giga (10^9)	ns	= nanosecond	SCR	= silicon controlled rectifier
bp	= bandpass	gnd	= ground(ed)			sec	= second(s)
c	= centi (10^{-2})	H	= henry(ies)	p	= pico (10^{-12})	std	= standard
C	= carbon	hr	= hour(s)	pc	= printed (etched) circuit(s)	trmr	= trimmer
ccw	= counterclockwise	HP	= Hewlett-Packard	pk	= peak	u	= micro (10^{-6})
coax.	= coaxial	Hz	= hertz	pn	= positive-negative-positive	usec	= microsecond
coef	= coefficient	if.	= intermediate freq.	p/o	= part of	V	= volts
com	= common	intl	= internal	p-p	= peak-to-peak	var	= variable
CRT	= cathode-ray tube	k	= kilo (10^3)	prgm	= program		
cw	= clockwise	lb	= pound(s)	prv	= peak inverse voltage(s)	w/	= with
d	= deci (10^{-1})	lpf	= low-pass filter(s)	ps	= picosecond	w/o	= without
dB	= decibel	m	= milli (10^{-3})	pwv	= peak working voltage	wiv	= working inverse voltage
ext	= external	M	= mega (10^6)	rf	= radio frequency		
F	= farad(s)	ms	= millisecond				

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a simplified explanation of some of the circuits used in the Model 1830A followed by a general description of the circuit functions and a detailed description of the operating circuits. Refer to the overall block diagram in Figure 4-4 and to the schematics in Section VIII while reading the text of this section.

4-3. SIMPLIFIED CIRCUITS.

4-4. Information about the more common circuits used in this instrument is contained in the following paragraphs. The circuits are shown in a simplified manner for explanation purposes, and not all aspects of the operation of each circuit are covered. However the information presented should be helpful in understanding the operation of the circuit and its use in this instrument.

4-5. ATTENUATOR.

4-6. The attenuator used in this instrument is a pi type network as shown in Figure 4-1. It is quite common and is used frequently in HP equipment. An attenuator is used to reduce the amplitude of a signal by a predetermined amount so that measurement can be made of signals that would otherwise be greater than the dynamic range of the test instrument. When the attenuator is used for precision measurement it is also necessary to maintain proper impedance match to both the input signal and the output load as well as reducing the amplitude of the input signal. Thus, the network employed must perform the dual functions of attenuation and impedance matching. The network shown is that used for the first section of the Model 1830A attenuator. The second and third sections perform in the same manner. The pi network is designed to match a 50-ohm source to a 50-ohm load while reducing the signal amplitude by one-half. When connected to a 50-ohm load the circuit must look like 50 ohms to the input source, and of course the output of the attenuator must look like 50 ohms to the load.

4-7. Calculation of the input and output impedances of the pi network can be readily accomplished using the formula for determining the equivalent resistance of resistors in parallel. Since the equivalent resistance of R3 and the 50 ohm load in parallel results in a value equal to R2, the input signal is equally divided between the two. Therefore, the output at points C and D is one half of the input signal. Using the equivalent resistance previously determined and the values for R1 and R2 it can be seen that the source will see an apparent resistance of 50 ohms across points A and B. Thus, the three requirements of the

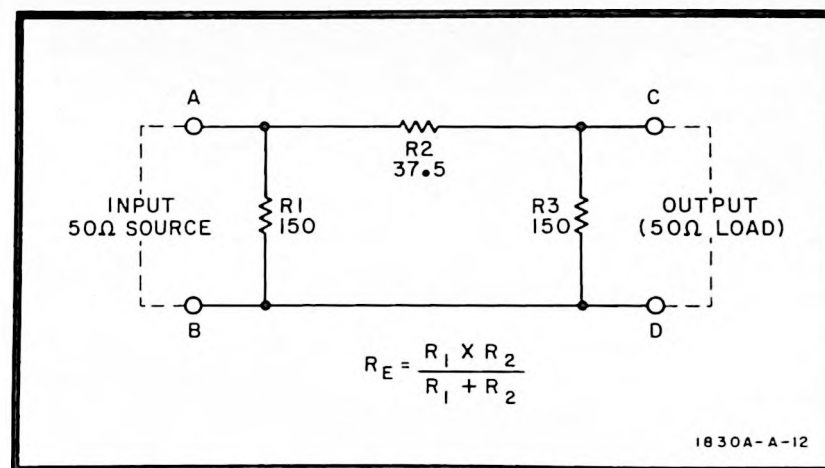


Figure 4-1. Simplified Attenuator

attenuator are satisfied: The input sees the load as 50 ohms, the load sees the input as 50 ohms, and output of the network to the load is one half of the input.

4-8. Naturally, for high frequency signals the electrical effects of such physical things as lead length (inductance) and proximity (capacitance) must also be established and maintained to attain such desirable capabilities as low VSWR and constant impedance from dc to the highest frequency to be employed.

4-9. CASCODE AMPLIFIER.

4-10. A basic cascode amplifier consisting of common base stage Q2 controlled by common emitter stage Q1 is shown in Figure 4-2. Operation in this manner provides the frequency response and gain required for wide band operation. High frequency response is normally limited due to the signal source impedance and the Miller effect capacitance which results in a degenerative feedback that increases with frequency and yields decreasing signal gain. For this reason Q1 is operated as a current amplifier rather than a voltage amplifier, working into the low input impedance of a common base stage, Q2. In this arrangement the high frequency response is limited only by the base to collector capacitance, the source impedance and the stray capacitance of the base circuitry. Note that the two transistors are effectively in series for both signal and current source.

4-11. To extend the gain of the cascode amplifier over a wider frequency range, emitter peaking compensation is used. At the lower frequencies the resistance of R1 limits the gain, but at the higher frequencies the decrease in reactance of C2 results in a lower emitter impedance than that offered by R1 alone. This causes an increase in circuit gain at the higher frequency which offsets the inherent reduction in amplifier gain.

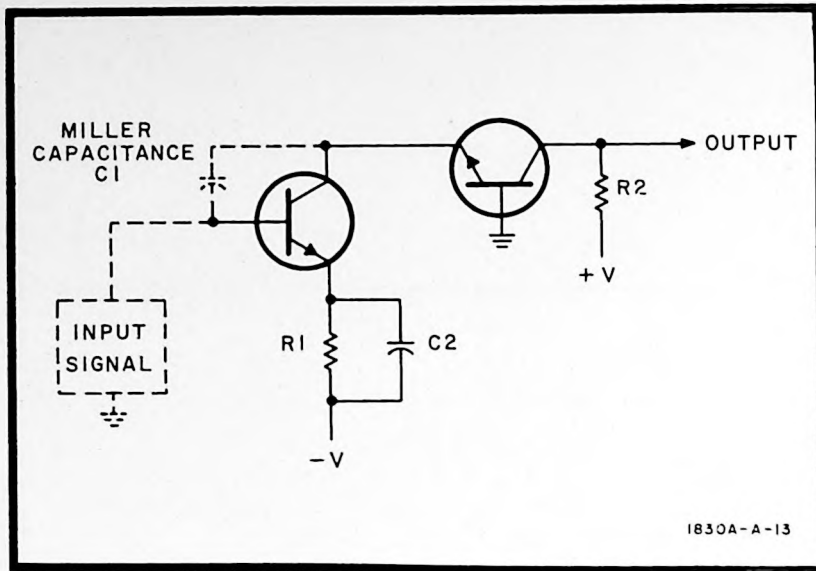


Figure 4-2. Cascode Amplifier

4-12. DIFFERENTIAL AMPLIFIER.

4-13. A differential amplifier circuit is used to amplify the difference in potential existing between two points while rejecting common mode signals. In this circuit, Figure 4-3, assume that both inputs are positive and of equal potential. In this case Q1 and Q2 are equally forward biased (and conducting) and the current flow through R2 and R3 are equal. While the voltage seen at C and at D changes, these are exactly equivalent and there is no change in their relationship. Now assume that the input A is a positive going signal and that input B is a negative signal of equal amplitude. Q1 is then forward biased to greater conduction and the conduction of Q2 is reduced. The voltage drops across R2 and R3 are therefore equal but opposite in polarity, and the output signal is the amplified difference between the two input signals. Thus, only the difference in voltage between the two inputs is amplified and common mode signals, such as stray pickup, are not apparent at the output.

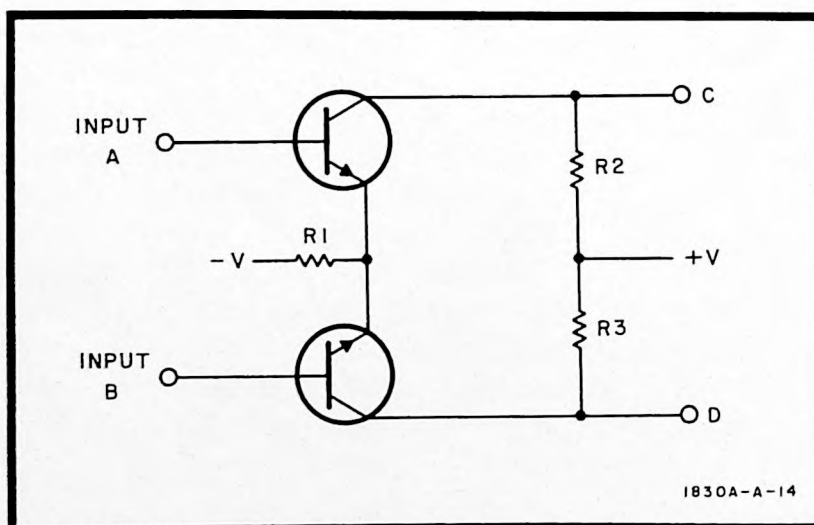


Figure 4-3. Differential Amplifier

4-14. FUNCTIONAL DESCRIPTION.

4-15. The functional block diagram of Figure 4-4 is designed to illustrate the signal flow and show how the display modes are controlled in the Model 1830A.

4-16. This instrument is designed to accept and amplify two input signals for CRT vertical display. The signals applied at INPUT A and B may vary widely in level. To accommodate this dynamic range each input has an attenuator which is used to reduce the signal amplitude input to the preamplifier. Since each channel has a separate attenuator, signal inputs of greatly different levels can be simultaneously amplified. Each attenuator has seven calibrated deflection factor ranges which can be selected. The Channel A and B inputs may be internally disconnected from the amplifier. When the Channel A ON/OFF and Channel B Polarity switches are in the OFF position their respective inputs are disconnected and terminated in 50 ohms. The Channel B input has a polarity switch which permits user selection of a signal display which is either positive (+) or negative (-) up.

4-17. The preamplifier, which is contained in an integrated circuit, is controlled in its operation to establish both the steady-state gain and to rapidly switch its outputs on and off as required by the DISPLAY mode selected. The mode display switch offers selection of five operating modes, and, through use of the Channel B polarity switch, a sixth mode, A-B, is available. Selection of an operating mode controls the operation of an Astable Multivibrator, a mode Flip Flop, and a mode Steering Switch. The combined operation of these accomplishes the required channel switching of the preamplifier. To set the steady state gain of the preamplifier VERNIER gain controls are provided for each channel, and a calibration adjustment (CAL) is used to initially adjust the overall amplifier gain to exactly correspond to the fixed deflection factor ranges of the attenuator. The preamplifier also performs the conversion of single ended input signals to a differential output. This differential output is controlled by the use of signal shunting diodes whose operation is set by the DISPLAY mode selected. If a display of the A input signal is desired, current is supplied through the steering switch to cause the Channel B signal shunting diodes to conduct and not pass any Channel B signal for amplification and display, while the reverse occurs if display of the Channel B input signal is desired. When the algebraic sum of both signals is to be displayed (A+B or A-B operation) the signal shunting diodes for both channels are reverse biased and the differential output consists of the resultant of both inputs. During Alternate operation each of the channel outputs is turned on and off by the diodes based on the Alternate Trigger received from the Time Base plug-in. This trigger is derived from the sweep unblanking gate, and it is used to change the state of the mode flip flop and alternately turn on the output of each channel for one full sweep. During CHOP operation, an astable multivibrator changes the state of the flip flop at a rate of approximately 250 kHz, and the steering switch drives the signal shunting diodes at this rate to produce an output consisting of many small portions of both input signals.

4-18. The differential output of the preamplifier drives a Delay Line which delays the vertical signals approximately 55 nanoseconds. This provides sufficient time for the

sweep to be initiated before the vertical signal is applied to the CRT deflection plates and permits viewing of the portion of the vertical signal causing the time base trigger.

4-19. For most measurements it is desirable to synchronize the horizontal sweep to the vertical input signals. A SYNC signal for this purpose can be obtained from the Channel A input signal or from the composite signal available at the output of the preamplifier. Both amplified signals are available at a SYNC selector pushbutton switch, and allows the operator to select the sync signal to be provided to the Time Base for initiating the sweep.

4-20. DETAILED DESCRIPTION.

4-21. ATTENUATORS.

4-22. The Vertical Amplifier is designed to operate with a 50-ohm system signal source, keeping VSWR and reflections to a minimum. This 50-ohm system is also ideal for probing applications since it provides a constant load impedance and allows direct probing of high frequency signal sources with minimum signal degradation from capacitive loading. The attenuator has seven switched ranges. Three pi sections are used in various combinations to obtain the desired attenuation while maintaining the input and output impedance of the attenuator at 50 ohms on all ranges.

4-23. Each of the three series sections of the attenuator has a fixed division ratio. The first divides the input signal by 2, the second by 5, and the third by 10. On the minimum deflection factor range (.01V/DIV) none of the pi sections are utilized and the signal is coupled directly to the preamplifier. When .02V/DIV of deflection is desired, only the first section (which divides the signal by a factor of two) is used. If a deflection factor of .1V/DIV is employed, the first section and the second section (divide by two and divide by five) are in series with the incoming signal; while a display of 1V/DIV requires that all three sections be used.

4-24. Adjustment to exactly set the calibration of the fixed VOLTS/DIV ranges is accomplished by varying the amplifier gain. Refer to Figure 3-2 and to paragraph 4-32 for more detailed information on how this is accomplished. All circuit components of the attenuator are fixed and no variable or compensating adjustments are employed. Input capacitance, signal division and frequency response are therefore not subject to misadjustment.

4-25. INPUT AND POLARITY SWITCHING.

4-26. For some signal measurements it may be desirable to reverse the displayed polarity of the input signal. This capability is provided for the Channel B input signal only. A polarity switch is used between the Channel B attenuator output and the Channel B preamplifier and

provides the option of viewing a positive up, or a negative up signal. When +UP is selected, positive signals are displayed upwards from the base line, and when -UP is selected, negative signals are displayed up. This switch can also disconnect the input signal from the amplifier. In the OFF position the front panel signal INPUT is disconnected from the amplifier and terminated in 50 ohms. This maintains the impedance seen by the input signal and eliminates possible variations in the signal source due to reflections caused by mismatch.

4-27. Display of the Channel A input signal is always positive up, since no switching is provided. The Channel A input signal can also be disconnected from the amplifier by switching to OFF, and the front panel INPUT for this channel is also properly terminated in 50 ohms when switched off.

4-28. PREAMPLIFIER OPERATION.

4-29. GENERAL DESCRIPTION. After passing through the attenuators and input switching, the desired INPUT signals are amplified for display. An Integrated Circuit assembly, U1, is used to amplify and control the level of the displayed signal for both channels. The signal gain of each channel is independently established, and each output is controllable at all levels ranging from completely off to full output. Display of a desired input signal is established by operator selection of a DISPLAY mode. This selects the operation of a multivibrator, a flip-flop and an alternate trigger amplifier to control the preamplifier output. The operation of each of these circuits is described later in this section. It is their combined operation that is used to control the output of the Input Amplifier, U1.

4-30. INPUT AMPLIFIER. The Channel A INPUT signal is always applied to pin 8 of the Input Amplifier. The dc level applied to pin 10 determines if any output signal will result as well as establishing the output level of the signal. An INPUT signal from Channel B can be fed into this amplifier at either pin 3 or pin 7, and the input used is established by operator choice of a +UP or -UP display. When +UP is selected the input signal is applied to pin 7, while selection of a -UP display applies the Channel B signal to pin 3. Control of the Channel B signal output level is determined by the dc level applied to pin 5. Vertical positioning of the Channel A Input signal is controlled by the dc offset voltage into pin 12. For Channel B Input signals the position of the vertical display is controlled through the dc offset voltage introduced at pin 3 when in +UP, or at pin 7 when operated in -UP. A differential output signal for driving the delay line, A4, appears at pins 1 and 14 of the input amplifier.

4-31. INPUT AMPLIFIER CIRCUIT DETAILS. The integrated circuit assembly, U1, contains two sets of differential input amplifiers and their associated gain controlling diodes. The transistors have closely matched gain characteristics and, being physically adjacent, provide

comparable temperature tracking. This results in maintaining constant gain with changes in input levels or signal polarities. Additionally, drift during warm-up and operation of this instrument is almost non-existent. Each differential amplifier is operated at a fixed gain level, regardless of the display deflection factor selected by the VOLTS/DIV switch. However, use of a VERNIER control provides for decreasing the gain if a lesser, uncalibrated, deflection factor is desired on any range.

4-32. The Channel A and the Channel B input amplifiers are similar in operation, and use a differential NPN transistor configuration whose output levels are set by controlling the bias applied to an associated signal shunting diode pair. The operating gain of the vertical amplifier is established by controlling the conduction of A2Q4 for Channel A and A2Q5 for Channel B. These transistors are used as current sources for the signal shunting diodes and the preamplifier; and their operating level is established by the applied base bias obtained from the setting of the front panel Calibration and Vernier controls. The CAL and VERNIER controls are in series and form part of a voltage divider between the +15V and -12.6V supplies. With these controls set to their minimum resistance (fully cw) position the current flow is decreased, and the amplifier gain is maximum. Similarly, when adjusted for maximum resistance (fully ccw) the signal shunting diodes are forward biased, shunting the signal and reducing the amplifier output to minimum.

4-33. VERTICAL POSITIONING.

4-34. Each channel of the amplifier has a POSITION control located on the front panel. Positioning is accomplished by varying the dc offset voltage into the amplifier. This results in shifting the dc level of the vertical output and therefore causes the CRT display to be moved up or down. The position offset voltage for Channel A is always the input to pin 12 of U1; however the Channel B polarity selection switch interchanges the Channel B signal and position inputs to the IC. Selection of a +UP display results in applying the B INPUT signal to pin 7 of U1 and the POSITION voltage to pin 3. During operation in the -UP condition the INPUT signal is applied to pin 3 and the POSITION voltage to pin 7. Because changing from +UP to -UP relocates the positioning voltage input to the other half of the differential amplifier, the rotation direction of the POSITION control also reverses in controlling the vertical position of the Channel B signal.

4-35. DISPLAY SELECTION.

4-36. The display mode switching logic is based on the use of a JK flip-flop circuit in an integrated circuit package, A2U1; an astable multivibrator, A2Q8 and Q9; and an alternate trigger amplifier, A2Q10 and Q11. The flip flop has a dc set and reset capability, two dynamic logic performing inputs and two outputs. Each of the outputs, Q and $\bar{Q}$, read out the state of the flip-flop. The flip-flop outputs drive current steering switches, A2Q6 and A2Q7

whose outputs are used to control the channel switching diodes of U1 and thus determine the signal to be displayed. The operating power for the flip-flop set and reset control and for operation of the multivibrator is applied by the DISPLAY switch. Flip-flop operation in the Alternate and Chop modes is set by the alternate trigger amplifier. The input and output voltage states of the flip-flop for the various display modes is provided in the Tables and waveform photographs in Section VIII of this manual.

4-37. A AND B OPERATION.

4-38. When display of the Channel A INPUT signal is selected, the flip-flop is placed in the set mode. This results in a forward biasing of the Channel B signal shunting diodes into conduction, shunting the Channel B signal and allowing only the Channel A signal to be amplified and displayed. If a Channel B display is desired the flip-flop is placed in the reset mode, the Channel A diodes are made conducting and shunt the Channel A signal, while the Channel B INPUT signal is amplified for display. To obtain an A + B display, the current source for the steering switch transistors, A2Q6 and Q7, is interrupted. Since they provide the main current source for the shunting diodes, the diodes are not-conducting and both channels are on simultaneously, independent of the state of the flip flop.

4-39. CHOP OPERATION.

4-40. Selection of the CHOP mode sets the astable multivibrator, A2Q8 and Q9 into operation, and removes the dc set and reset inputs to the flip-flop, A2U1. The state of the flip-flop outputs then depends on the $\bar{J}\bar{K}$ logic input levels to the flip-flop. The multivibrator operates at a free running frequency of approximately 500 kHz, and its output is used as the $\bar{J}\bar{K}$ input to the flip-flop at pins 6 and 9. A dynamic voltage swing of 0.8V is adequate to toggle the flip-flop. The other $\bar{J}\bar{K}$ inputs, at pins 5 and 10, is held false during the sweep time through the action of the alternate trigger buffer amplifier A2Q10 and Q11. In this arrangement the flip flop changes its output state once each time the multivibrator goes through a complete cycle.

4-41. During the time the sweep is off, the input to pins 5 and 10 is held true. This is accomplished by the action of A2Q10 and Q11, which reacts to the negative going portion of the alternate trigger signal occurring at the end of a sweep. Although the chop astable multivibrator runs continuously in the Chop mode, the flip-flop will not change state while the $\bar{J}\bar{K}$ inputs at pins 5 and 10 are true. Therefore the Channel switching operation is inhibited during the time the sweep is off and the trigger circuit is armed, preventing the time base from being triggered on Chop transients. Only once during each cycle of operation will the multivibrator produce an output which will cause the flip flop to change state. Thus, with the multivibrator operating at 500 kHz, the flip flop produces an output at a 250 kHz rate. The 'True' Q and $\bar{Q}$ output level is +4.5

volts and the 'False' output level is + 3.5 volts. These outputs control the current steering switch, A2Q6 and Q7, and cause the signal steering diodes in A2U1 to alternately conduct at the 250 kHz rate to display portions of the signal from each input channel.

4-42. Use of the circuit arrangement explained above results in chopping transients which are quite small in amplitude and of extremely short duration. Therefore, false triggering on chopping transients will not normally occur. In contrast to many other multiple channel vertical amplifiers having a chop capability, there is no requirement for a chopped blanking output for reducing display intensity while the chopping is being accomplished.

4-43. ALTERNATE OPERATION.

4-44. When Alternate operation is selected, all of the other DISPLAY switch sections are mechanically released to their off positions. It is this action which sets up the electrical conditions required for Alternate operation. The ALT portion of the Display selector switch assembly has no electrical connections made to it. In Alternate operation the dc set and reset inputs are removed from the JK flip flop, A2U1, and the astable multivibrator, A2Q8 and Q9, is not operational. The flip flop outputs, Q and $\bar{Q}$, are determined by the $\bar{J}\bar{K}$ input level at pins 5 and 10. The signal used to provide this input originates in the horizontal Time Base plug-in and is called the Alternate Trigger. It is directly related to the unblanking gate signal which is used to turn on the CRT intensity. A2Q10 and Q11 are used as a buffer amplifier that is controlled by the Alternate Trigger input. Each time the unblanking gate ends (at the termination of each sweep), the negative going portion of the alternate trigger signal causes the collector of A2Q11 to go positive. Each positive input to the flip flop results in a reversal in its output states. Therefore, each time the alternate trigger input goes negative the amplifier produces a positive input to the flip flop input at pins 5 and 10, causing it to change states after the termination of each sweep. These flip flop outputs, Q and $\bar{Q}$, alternate between their 'true' (+4.5V) and 'false' (+3.5V) states, causing the signal inputs to be alternately displayed. The rate at which the channels are switched is directly established by the rate at which the Time Base is triggered. And, since Channel switching is accomplished after the termination of a sweep, there can be no display of switching transients.

4-45. SYNC SELECTION.

4-46. The display sweep developed by the Time Base may be synchronized by an internal signal obtained from the Channel A input signal or by a composite of the signal input to both channels. Two separate amplifiers are used to develop the sync signal; one for Channel A and the second for the Composite sync signal.

4-47. The Channel A Sync Amplifier is directly driven by the Channel A input signal. The output of this emitter

follower, A2Q1, is made available at the SYNC selector switch, A2S1, for connection to the Sync Output jack, J3. A balance adjustment is provided, which is used to set the dc reference level of the sync amplifier output to correspond with the signal input dc reference level. The procedure for making this adjustment is given in Section V of this manual.

4-48. The signals which have been amplified by U1 provide the input to the Composite Sync Amplifier, A2Q2 and Q3. This signal input is available in differential form from U1 pins 1 and 14. A2Q2 and A2Q3 are used as an emitter coupled differential amplifier for the composite sync, and the single ended output of this amplifier is made available at the SYNC selector switch. The composite Balance adjustment in this circuit serves the same purpose as the Channel A Balance, establishing the dc output reference level in relation to the input dc level.

4-49. The SYNC selector switch, A2S1, allows for operator selection of the sync signal to be applied to the horizontal Time Base plug-in. An output of the Composite Sync signal is selected when the SYNC pushbutton is pushed in. Releasing the pushbutton to its out position provides an output of the Channel A SYNC signal.

4-50. When the output of a sync amplifier is not selected for output to the Time Base it is terminated to maintain the reflected output impedance as seen by the Time Base Sync amplifier input. Thus, selection of COMP SYNC for output to the Time Base results in terminating the output of the Channel A Sync Amplifier with A2R2, and selection of CH A SYNC causes the Composite Sync Amplifier output to be terminated by A2R3. The Sync signal provided to the time base is also always properly terminated in that instrument.

4-51. DELAY LINE.

4-52. The selected signals are applied to Delay Line assembly A4. The delay line has an impedance of approximately 150 ohms and provides a time delay of approximately 55 nanoseconds. This delay is adequate to allow the internal sync signal to trigger the Time Base for developing the sweep prior to beginning the display of vertical deflection. Without the insertion of this delay time in the signal path, the sweep would start after the signal reached the vertical deflection plates and the leading edge of fast risetime signals would not be displayed. To maintain signal fidelity the impedance of the delay line must be properly matched. Resistors A2R24 and A2R25 are used to match the input (driven) side of the delay line, and A5R4 and A5R5 are used for impedance matching of the delay line output to minimize signal reflection.

4-53. CHOP MULTIVIBRATOR.

4-54. A2Q8 and Q9 are used in an astable multivibrator configuration which operates only in the CHOP mode. Power is applied to the multivibrator through the CHOP

section of the mode DISPLAY switch. With the application of +4.8 volts the multivibrator operates at a free running frequency of approximately 500 kHz, as determined by the circuit RC constants. Its output, which approximates a square wave, is taken from the collector of A2Q9 and used as the $\overline{JK}$ input to the flip-flop, A2U1. If the signal input to the flip flop has a risetime of 40 nanoseconds or faster a dynamic voltage change of 800 millivolts (0.8V) will toggle the flip flop. The multivibrator output swings between the +3-volt and +4.5-volt levels, with a risetime which is more than adequate for this purpose. A photograph of the output wave shape and voltage levels is contained in Section VIII.

4-55. OUTPUT AMPLIFIER.

4-56. GENERAL. The output amplifier has five stages of amplification, with the active elements of each stage contained in an integrated circuit (IC) package. These five multi-transistor IC's are used to amplify the low level signal as received from the delay line to the level required to directly drive the vertical deflection plates of the CRT. The first four stages, U2-U5, are identical arrays of four transistors in a differential cascode configuration. The fifth, output, stage has its active elements connected in a current feedback arrangement. This serves to divide the signal output voltage requirement among the four transistors of this stage. It also results in a low output capacitance which facilitates matching the output impedance to the characteristic impedance of the CRT distributed deflection plate system.

4-57. The transistors of U2, U3, U4 and U5 are arranged as four stages of differential complementary cascode amplifiers. Each stage has emitter high frequency compensation and has good common mode rejection. Differential signals from the Delay Line, A4, are applied to the base inputs of U2Q1 and Q2, and are amplified in the succeeding stages to the level required to drive the CRT vertical deflection plates. Adjustable emitter peaking is used in the first stage, U2, to provide for precise setting of the high frequency gain response. The series combination of A5C2 and R6 has sufficient peaking range to adjust for overall high frequency variation in amplifier gain. A5R3 is used to introduce a dc balancing of the amplifier.

4-58. Fixed emitter peaking is used in subsequent stages. Special inductive peaking networks, A5Z1 - Z6 provide a high frequency inductive reactance to offset the small but cumulative end-to-end capacitances of the collector load resistors. Since the Delay Line introduces a somewhat greater amount of high frequency signal loss than occurs at low frequencies, an inductive resistive compensation network is used in the collectors of the second (U3), and third (U4) stages of the amplifier. At the higher frequencies the inductive reactance of A5L2 adds to the resistance of A5R22, and that of A5L3 to the resistance of A5R33 to increase the amplifier high frequency gain. Other compensation networks provide thermal stabilization. These RC networks are included in the

emitter to emitter circuits of U3 and U4.

4-59. The total amount of power dissipated in the Output Amplifier assembly is greatly reduced by "re-using" the current drawn by one stage to provide the bias requirements of another stage. As an example, the emitters of the output stage U6 form, in a common mode sense, a low impedance voltage source because if the base voltages are well defined so is the emitter voltage. With the required voltage drop introduced by A5R54 and R56, the combined collector currents of U4Q3 and Q4 is utilized as a part of the emitter bias current for U6. Since the output stage operates with greater current input than is required by U4, the additional current is returned to the +15V supply through A5R55. A similar feedback loop is used from the collectors of U3 to the emitters of U5. In addition, the desired bias voltage for the common base transistors of U4 and U5 is available for use. Under these conditions, transistor saturation is prevented, and rapid amplifier recovery from an over-driven off-screen condition is facilitated. A5R64 permits small gain adjustments of U5Q1 and Q2. Sufficient range is available to accommodate variations in the active components contained in the circuit.

4-60. A distributed transmission line type of vertical deflection plate system is used in the Model 183A/B Oscilloscopes, and a diode shunting arrangement is used in the scope to allow its use with the Model 1830A vertical amplifier or with one of the Series 180 vertical amplifiers. In the Model 1830A mode of operation a stabilized reference voltage of 57.1V and an unregulated voltage of approximately +60V is supplied to the Model 183A/B Oscilloscope for electrical arrangement of the deflection plates. The Oscilloscope also furnishes a total of approximately 110 ma through the deflection plates for the collector current supply of the output stage U6. Since the output stage, U6, has a large amount of current feedback, little voltage change is apparent at the base inputs of U6Q1 and Q2, regardless of the level of the input signal.

4-61. BEAM FINDER.

4-62. Current for operation of the first stage of the output amplifier, U2, is provided through the contacts of the Oscilloscope Find Beam switch. The -12.6V current supply for the initial stage of the output amplifier normally flows through this switch. When the spring-loaded Find Beam switch is depressed, this direct supply of current is disconnected and A5R47 is placed in series with the -12.6V supply. The current available to the amplifier is greatly restricted with a consequent reduction in dynamic range of the output amplifier. As a result, the signal will appear within the CRT display area regardless of the input signal amplitude or the setting of the position controls. A similar action simultaneously occurs in the Oscilloscope horizontal and intensity gate amplifier. This will guide the operator in adjusting the horizontal and vertical positioning controls, intensity, etc., to bring the display on screen. A5R61 provides a balance

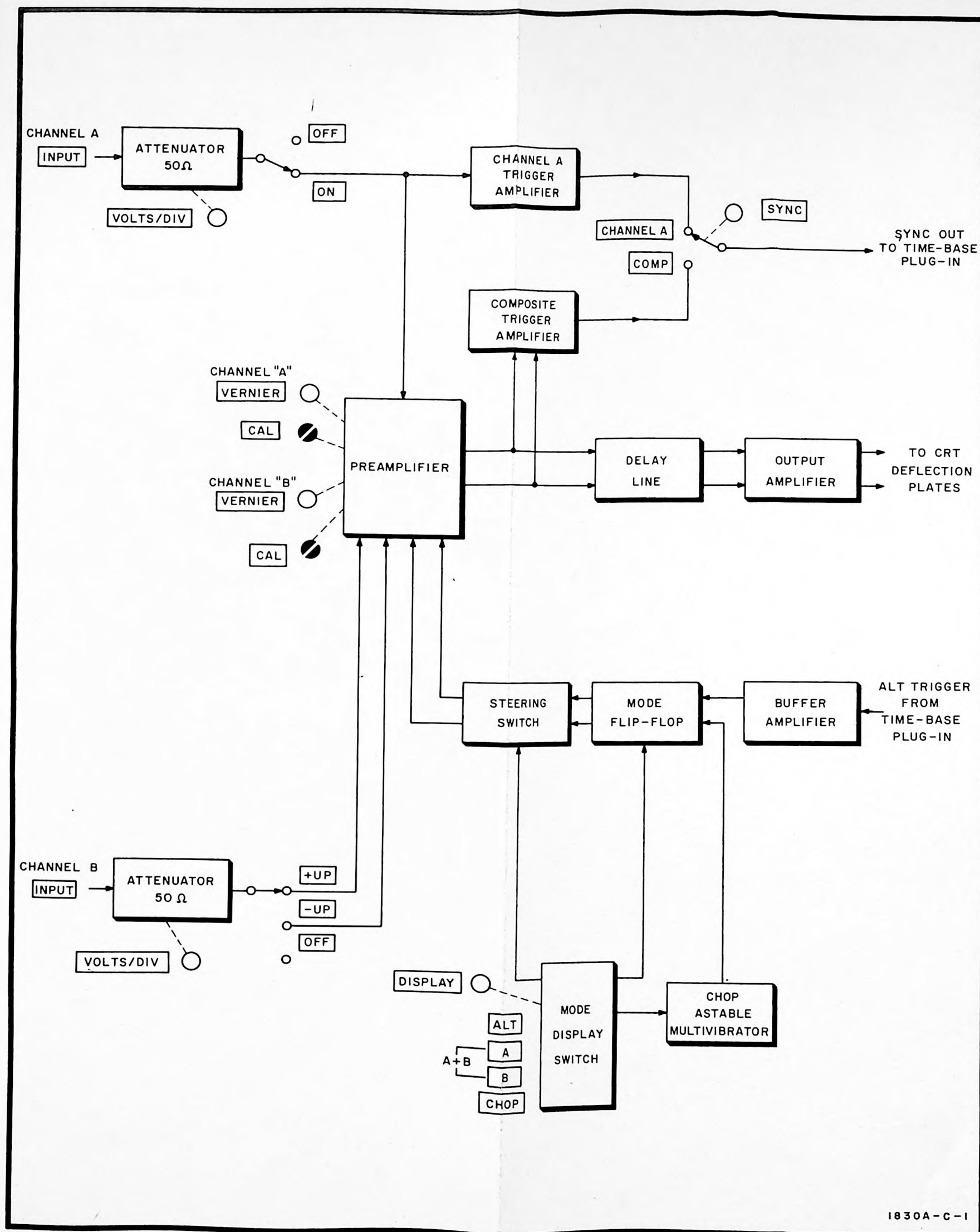
Model 1830A

adjustment to set the trace to center screen when the FIND BEAM switch is depressed.

4-63. POWER SUPPLY DECOUPLING.

4-64. Decoupling networks are used on each printed circuit assembly for the supply voltages used on that board. The use of decoupling is important to prevent

extraneous signals or noise from being introduced into the Vertical Amplifier circuitry from the power supplies or the supply leads. Decoupling also prevents transients originating in the Vertical Amplifier from being applied to the Oscilloscope mainframe or the Time Base plug-in through the power supply. In this instrument the +35V, +15V and -12.6V supply leads are decoupled on the printed circuit assembly requiring their use.



1830A-C-1

Figure 4-4. Overall Block Diagram

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Use
Type	Model		
VHF Oscillator	HP 3200B	10MHz –250 MHz, cw. 50-ohm output, >60 mV.	Bandwidth Check
RF Voltmeter	HP 3406A	250 MHz bandwidth	Bandwidth Check
Fast Risetime Pulse Generator	HP 213B or 1105A/1106A	Risetime <100 psec, free running.	Risetime Check and Adjust
Power Supply	HP 6111A	.06V to 5V, variable. ±0.01% accuracy. <0.1Ω output impedance	Deflection Factor Check and Adjust

Accessories Required:

- 1 50-ohm T connector HP Model 11063A
- 1 50-ohm BNC T-connector,
- 1 50-ohm Attenuator, 10 dB GR type 874 G10
- 1 GR to Male BNC adapter GR type 874-QBPA
- 1 GR to Female BNC adapter GR type 874-QBJA
- 2 50-ohm coax. cable 9''L, BNC to BNC HP Model 10502A.
- 1 50-ohm Male BNC, user modified w/short circuit
- 1 non-inductive alignment tool, blade tip.
- 2 50-ohm coax. cable, length as required. BNC to BNC.
- 1 shielded cable, BNC to wire terminals.
- 2 50-ohm Attenuator, 20 dB, GR type 874G20
- 1 50-ohm Power Tee, GR type 874TPD
- 1 50-ohm Termination, GR type 874W50B

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides the performance check and adjustment procedures for the Model 1830A. Troubleshooting information, schematic diagrams, and component location identification are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment for maintaining and checking the performance of the Model 1830A is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be used for the performance check and adjustments. Use a non-metallic alignment tool for making the required adjustments.

5-5. OPERATION AND PERFORMANCE CHECKS.

5-6. The operation of the Model 1830A may be checked without the use of additional test equipment by using the Calibrator of the Model 183A/B Oscilloscope as a signal source. These operating tests will functionally check each of the operating DISPLAY modes and the operation of the front panel controls. If desired, the Performance Check or the Adjustment Procedure may be accomplished separately.

5-7. The performance check verifies whether or not the Model 1830A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check.

5-8. A Performance Check Record is included in this manual at the end of the Performance Check Procedure. As the initial performance check is accomplished, the actual reading should be entered on the form. The form may then be removed from the manual and filed in a safe place, so that readings taken at a later date can be compared with the original readings.

5-9. The operation check must be performed in the sequence given. Do not attempt to start a procedure in mid-sequence, as succeeding steps are dependent on control settings and results of previous steps.

5-10. PRELIMINARY SET-UP.

5-11. Lock the Model 1830A together with a compatible Time Base Plug-in and install in a Model 183A/B Oscilloscope mainframe. Apply power and allow a fifteen minute warm-up.

5-12. OPERATION CHECK.

Set controls as follows:

Model 183A/B Oscilloscope:

HORIZONTAL	X1
HORIZONTAL	INT
EXT VERNIER	CAL
Calibrator INT/EXT (rear panel)	INT

Model 1830A Dual Channel Vertical Amplifier:

DISPLAY	A
SYNC	CH A
VERNIER, A & B	CAL
Channel A ON/OFF	ON
Channel B OFF/Polarity	+UP
VOLTS/DIV, A & B	0.2

Time Base:

NEG/POS	POS
INT/EXT	INT
AC/DC	AC
$\div 1/\div 10$	$\div 1$
SWEEP TIME/DIV	0.5 usec
MODE	AUTO

5-13. CHANNEL A OPERATION.

a. Connect CALIBRATOR OUT to Channel A INPUT with a short length of 50-ohm cable.

b. Set CALIBRATOR FREQ to 1 MHz and AMPL to 0.5V.

c. Adjust the Time Base TRIGGER LEVEL control as required and observe a series of negative-going pulses of 2 1/2 divisions amplitude.

d. Rotate the A POSITION control, observing that the signal can be positioned vertically at any location on the display and that clock-wise (cw) rotation of the control positions the signal to the top of the display, while counter clock-wise (ccw) rotation positions it to the bottom of the display.

e. Rotate the Channel A VERNIER CAL control ccw and observe that the amplitude of the displayed signal can be reduced to approximately 1 division. Return the control to the CAL detent position.

f. Switch from Channel A ON to OFF. The signal should no longer be seen. Return the switch to ON.

g. Change SYNC from CH A to COMP. The signal should continue to be displayed. (If it disappears, the Time Base TRIGGER LEVEL control may not have been set to the center of its operating range.) Return SYNC to CH A.

h. Change DISPLAY to B. The displayed signal should disappear.

i. Simultaneously depress both A and B DISPLAY pushbuttons. The signal should reappear, and be controllable in position with both A POSITION and B POSITION CONTROLS.

j. Change DISPLAY to ALT. The signal should be displayed by the trace controlled by the Channel A POSITION control. No signal should be present on the trace controlled by the Channel B POSITION control.

k. Change DISPLAY to CHOP. The signal should be displayed by the sweep trace controlled by the Channel A POSITION control. No signal should be observed on the sweep trace controlled by the Channel B POSITION control.

5-14. CHANNEL B OPERATION.

a. Disconnect the CALIBRATOR OUT from Channel A and connect to Channel B INPUT.

b. Change DISPLAY to B and SYNC to COMP.

c. Adjust the Time Base TRIGGER LEVEL control, if required, to observe a series of negative-going pulses of 2-1/2 divisions amplitude.

d. Rotate the Channel B POSITION control, observing that the signal can be positioned vertically at any location on the display and that cw rotation positions the signal to the top of the display while ccw rotation positions it to the bottom of the display.

e. Rotate the Channel B VERNIER CAL control ccw and observe that the amplitude of the displayed signal can be reduced to approximately 1 division. Return the control to the CAL detent position.

f. Switch from Channel B +UP to -UP. The negative-going signal should now be positive-going. (Remember that the output of the Model 183A/B Calibrator is a negative-going signal.)

g. Rotate the Channel B POSITION control, observing that the signal can be positioned vertically at any location on the display and that cw rotation positions the signal to the bottom of the display, while ccw rotation positions it to the top of the display.

h. Switch from -UP to OFF. The signal should no longer be seen. Return the switch to +UP.

5-15. A + B AND A - B OPERATION.

a. Connect the CALIBRATOR OUT to the Channel A INPUT and the Channel B INPUT with a T-connector and two short lengths of 50-ohm cable. Placing the T-connector at the Channel A INPUT will facilitate access to the front panel controls.

NOTE

Both channels of the 1830A are now connected in parallel and do not present a 50-ohm load to the input signal. Therefore the deflection factor for the displayed signal will not be correctly indicated by the setting of the VOLTS/DIV control.

b. Set DISPLAY for A + B operation by simultaneously depressing the A and B pushbuttons.

c. Set Channel B VOLTS/DIV to 0.1 and SYNC to CH A.

d. Observe a negative-going displayed signal of approximately 5 divisions amplitude.

e. Switch to -UP and observe a positive-going displayed signal of approximately 1-1/2 divisions amplitude.

5-16. ALTERNATE OPERATION.

a. Set DISPLAY to ALT and SYNC to CH A.

b. Observe a negative-going signal which can be controlled in position with the Channel A POSITION control and a negative-going signal which can be controlled in position with the Channel B POSITION control.

c. Set Time Base SWEEP TIME/DIV to 0.1 sec and observe the alternating display of two signals. The Channel A signal will be somewhat less than 4 divisions amplitude and the Channel B signal somewhat less than 2 divisions amplitude.

5-17. CHOP OPERATION.

a. Set DISPLAY to CHOP and Time Base SWEEP TIME/DIV to 0.5 usec.

b. Observe that both signals are displayed with no chopping transients visible.

c. Disconnect the CALIBRATOR OUT from the Channel A and B INPUTS.

5-18. This completes the operational check and verifies the proper operation of the selectable DISPLAY modes and front panel controls. The following performance tests require the use of the test equipment listed in Table 5-1 or their equivalent. The initial control settings required for the performance checks are provided here so that these tests may be performed, if desired, separately from the operational checks.

5-19. PERFORMANCE CHECK.**NOTE**

Perform the Amplifier Calibration adjustment as given in Section III of this manual before attempting the Performance Check.

Set controls as follows:

Model 183A/B Oscilloscope:

HORIZONTAL	X1
HORIZONTAL	INT
EXT VERNIER	CAL
Calibrator INT/EXT (rear panel)	INT

Model 1830A Dual Channel Vertical Amplifier:

DISPLAY	A
SYNC	CH A
VERNIER, A & B	CAL
Channel A ON/OFF	ON
Channel B OFF/Polarity	+UP
VOLTS/DIV, A & B	0.2

Time Base:

NEG/POS	POS
INT/EXT	INT
AC/DC	AC
÷1/÷10	÷1
SWEEP TIME/DIV	0.5 usec
MODE	AUTO

5-20. BANDWIDTH.

a. Connect the VHF Oscillator and RF Voltmeter to Vertical Amplifier Channel A INPUT. (See Figure 5-1)

b. Set DISPLAY to A and SYNC to CH A.

c. Set VHF Oscillator frequency to 10 MHz.

d. Set channel A VOLTS/DIV and/or VHF Oscillator output to obtain exactly six divisions of vertical display.

e. Note the output of the VHF Oscillator as indicated by the RF Voltmeter.

f. Set VHF Oscillator frequency to 250 MHz.

g. Adjust VHF Oscillator output to obtain the same output level on the RF Voltmeter as obtained in step e.

h. Observe amplitude of vertical display which should be greater than 4.2 divisions.

i. Connect the VHF Oscillator and RF Voltmeter to Vertical Amplifier channel B INPUT.

j. Set DISPLAY to B and SYNC to COMP.

k. Repeat steps c through h for channel B.

l. Disconnect equipment.

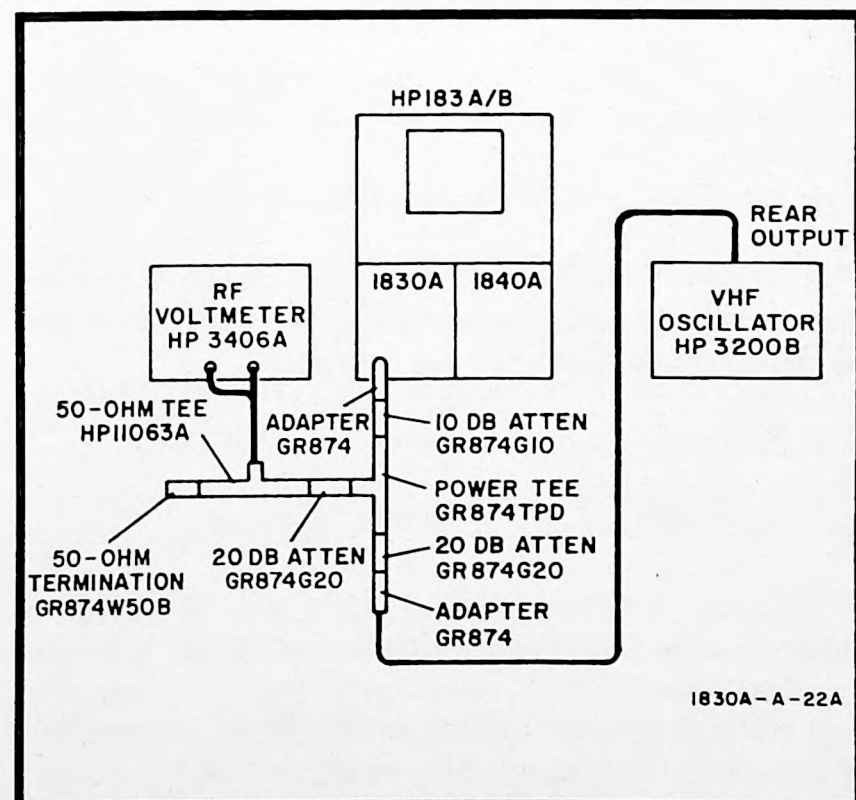


Figure 5-1. Bandwidth Test Set-up

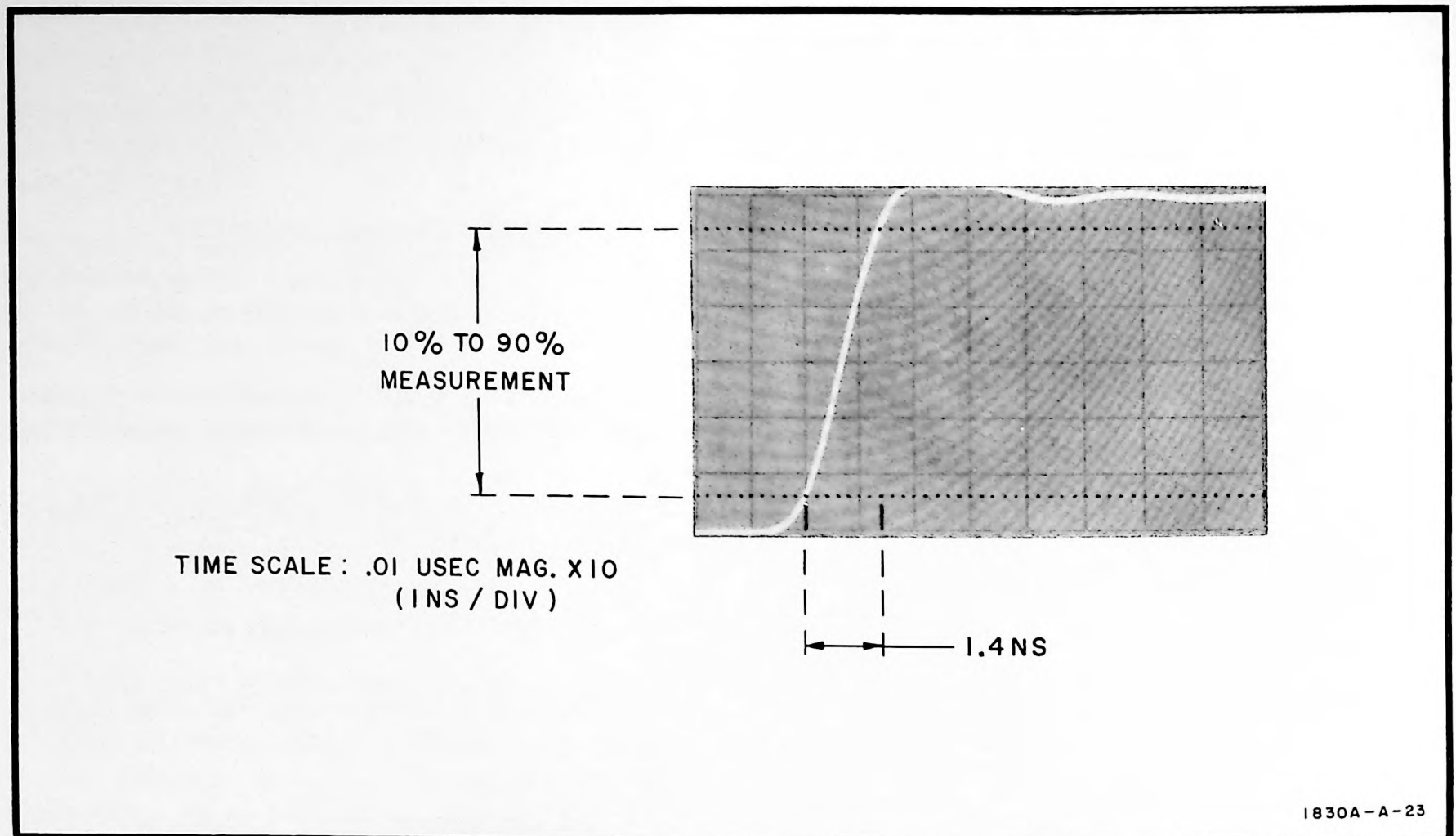


Figure 5-2. Risetime Measurement

5-21. RISETIME.

- a. Connect Pulse Generator to Channel A INPUT.
- b. Set Time Base for INT triggering, SWEEP TIME/DIV to .01 usec and adjust TRIGGER LEVEL control for a stable display.
- c. Set DISPLAY to A and SYNC to CH A.
- d. Adjust channel A VOLTS/DIV and VERNIER to display a pulse amplitude of exactly 6 divisions.
- e. Set HORIZONTAL MAGNIFIER to X10.
- f. Measure risetime. Risetime should be 1.5 nanoseconds or less. (Disregard any overshoot which may be caused by the fast-rise pulse generator.)
- g. Connect Pulse Generator to Channel B INPUT.
- h. Set DISPLAY to B and SYNC to COMP.
- i. Adjust Channel B VOLTS/DIV and VERNIER to display a pulse amplitude of exactly 6 divisions.
- j. Measure risetime which should be 1.5 nanoseconds or less.
- k. Disconnect equipment.

5-22. DEFLECTION FACTOR.

CAUTION

A calibrated Power Supply having an output impedance of less than 0.1 ohm is required for this check. Do NOT use a power supply having a high output impedance. Damage to the power supply and/or the Model 1830A may result. If a low output impedance power supply is not available, an alternate procedure is provided; however, for certain VOLTS/DIV ranges the results are not as accurate as when a low impedance power supply is used.

- a. Set the displayed trace exactly on the bottom graticule line with the channel A POSITION control.
- b. Connect the Power Supply output to channel A INPUT.
- c. Set channel A VOLTS/DIV to 1 and Power Supply output to 5 volts.
- d. Set VERNIER CAL to CAL detent position and Time Base to AUTO.

e. Adjust CAL front panel screwdriver control to provide exactly 5 divisions of deflection.

f. Disconnect Power Supply and repeat steps a through e.

g. Set Power Supply output and VOLTS/DIV control to each of the conditions given in Table 5-2, and check accuracy of the displayed signal. Accuracy in all cases should be within $\pm 3\%$.

h. Set DISPLAY to B.

i. Set the displayed trace exactly on the bottom graticule line with the channel B POSITION control.

j. Disconnect Power Supply output from channel A and connect to channel B INPUT.

k. Repeat steps c through g for channel B.

Table 5-2. Deflection Factor Check

VOLTS/DIV	POWER SUPPLY	DEFLECTION
1	+5 V	Adjust to provide exactly 5 div.
.5	+3 V	6 div ± 0.18
.2	+1.2 V	6 div ± 0.18
.1	+0.6 V	6 div ± 0.18
.05	+0.3 V	6 div ± 0.18
.02	+0.12 V	6 div ± 0.18
.01	+0.06 V	6 div ± 0.18

5-23. DEFLECTION FACTOR: (ALTERNATE METHOD)

a. Connect CALIBRATOR OUT to channel A INPUT with short length of 50-ohm cable.

b. Set CALIBRATOR FREQ to 1 MHz and AMPL to 0.5V.

c. Set SWEEP TIME/DIV to 0.5 μ SEC and MODE to AUTO.

d. Set VERNIER CAL to CAL detent position, DISPLAY to A and SYNC to CH A.

e. Set channel A VOLTS/DIV to 0.1 and adjust CAL front panel screwdriver control to provide exactly 5 divisions of deflection.

f. Set VOLTS/DIV control and CALIBRATOR OUT to each condition given in Table 5-3 and check accuracy of displayed signal. Accuracy should be within $\pm 3\%$.

g. Disconnect CALIBRATOR OUT from channel A INPUT and connect to channel B INPUT.

h. Set SYNC to COMP and DISPLAY to B.

i. Repeat steps e and f for channel B.

Table 5-3. Alternate Deflection Factor Check

VOLTS/DIV	CALIBRATOR OUTPUT	DEFLECTION
1	0.5 V	0.5 div ± 0.015
.5	0.5 V	1 div ± 0.03
.2	0.5 V	2.5 div ± 0.075
.1	0.5 V	Adjust to provide exactly 5 div.
.05	50 mV	1 div ± 0.03
.02	50 mV	2.5 div ± 0.075
.01	50 mV	5 div ± 0.15

5-24. TRIGGERING.

a. Set controls as indicated.

Time Base:

INT/EXT INT
 $\div 1/\div 10$ $\div 1$
 SWEEP TIME/DIV 0.5 μ SEC

Model 1830A:

DISPLAY A
 SYNC CH A
 VOLTS/DIV Channel A & B 0.5

Model 183A/B Oscilloscope:

CALIBRATOR AMPL 0.5V
 CALIBRATOR FREQ 1 MHz

b. Connect CALIBRATOR OUT to channel A INPUT with short length of 50-ohm cable.

c. Adjust Time Base TRIGGER LEVEL to obtain a stable display.

d. Disconnect CALIBRATOR OUT from channel A and connect to channel B INPUT.

e. Set SYNC to COMP and DISPLAY to B.

f. Adjust Time Base TRIGGER LEVEL to obtain stable display.

5-25. This completes the Performance Check. If the instrument does not meet Model 1830A Specifications, the Adjustment Procedure which follows should be undertaken. If this does not result in satisfactory instrument performance refer to Section VIII of this manual for troubleshooting and maintenance information.

MODEL 1830A
PERFORMANCE CHECK RECORD

Instrument Serial No. _____

Check	Min	Reading	Max
<u>Bandwidth</u> Channel A 10 MHz 250 MHz Channel B 10 MHz 250 MHz	 	 6 div _____ 6 div _____	
<u>Risetime</u> Channel A Channel B		 _____ _____	 ≤1.5 nsec ≤1.5 nsec
<u>Deflection Factor</u> Channel A 1 .5 .2 .1 .05 .02 .01 Channel B 1 .5 .2 .1 .05 .02 .01	 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div 5.82 div	 5 div _____ _____ _____ _____ _____ _____ _____ 5 div _____ _____ _____ _____ _____ _____	 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div 6.18 div
<u>Triggering</u> Channel A Channel B	 stable display stable display	 _____ _____	 Yes or No Yes or No

5-26. ADJUSTMENT PROCEDURE.

5-27. The following paragraphs outline the procedure for accomplishing the adjustments required for the Model 1830A. To gain access to the adjustments the lower left side cover must be removed on the Model 183A and the bottom cover must be removed on the Model 183B. Prior to performing these adjustments make certain that the Model 183A/B Oscilloscope is operating within specifications. Use the equipment recommended in Table 5-1 or similar equipment having at least equivalent capability. The adjustments should be performed in the sequence listed, since some adjustments are dependent on control settings and results of previous steps. The adjustment locations are identified in the photographs at the end of this section, and may be folded out for easy reference while performing the adjustments.

5-28. Lock the Model 1830A together with a compatible Time Base plug-in and install in a Model 183A/B Oscilloscope mainframe. Apply power and allow a 15 minute warm-up.

5-29. DEFLECTION FACTOR.

- a. Set controls as follows.

Model 183A/B CALIBRATOR:

FREQ 1 MHz
AMP 0.5V
INT/EXT (rear panel) INT

Time Base:

INT/EXT INT
÷1/÷10 ÷1
AC/DC AC
NEG/POS POS
SWEEP TIME/DIV 0.5 μ SEC

Model 1830A:

DISPLAY A
SYNC CH A
VOLTS/DIV, A & B 0.1
VERNIER, A & B CAL
Channel A ON/OFF ON
Channel B OFF/Polarity +UP

b. Connect CALIBRATOR OUT to channel A INPUT using a short length of 50-ohm cable.

c. Adjust Time Base TRIGGER LEVEL for stable display of the calibrator output pulses.

d. Set channel A front-panel CAL screwdriver control to maximum CW position.

e. Adjust Gain Adj. A5R64 to display signal of 5.5 divisions amplitude.

f. Adjust channel A front panel CAL screwdriver control to display exactly 5 divisions of signal.

g. Refer to Table 5-4 and check the accuracy for each condition given. The displayed signal should be within $\pm 3\%$ of that indicated in the table.

h. Disconnect CALIBRATOR OUT from channel A and connect to channel B INPUT.

- i. Set DISPLAY to B and SYNC to COMP.

j. Adjust channel B front panel CAL screwdriver control to display exactly 5 divisions of signal.

k. Refer to Table 5-4 and check the accuracy for each condition given. The displayed signal should be within $\pm 3\%$ of that indicated in the table.

Table 5-4. Deflection Factor Adjustment

VOLTS/DIV	CALIBRATOR OUTPUT	DEFLECTION
1	0.5 V	0.5 div ± 0.015
.5	0.5 V	1 div ± 0.03
.2	0.5 V	2.5 div ± 0.075
.1	0.5 V	Adjust to provide exactly 5 div.
.05	50 mV	1 div ± 0.03
.02	50 mV	2.5 div ± 0.075
.01	50 mV	5 div ± 0.15

5-30. CHANNEL A SYNC BALANCE.

- a. Set controls as follows:

Model 183A/B Oscilloscope:

CALIBRATOR FREQ 1 MHz
CALIBRATOR AMP 0.5V

Time Base:

AC/DC AC

Model 1830A

DISPLAY A
SYNC CH A
VOLTS/DIV, channel A 0.5

b. Connect CALIBRATOR OUT to channel A INPUT using a short length of 50-ohm cable.

c. Adjust the Time Base TRIGGER LEVEL for a stable display, centering it in the range which results in a stable display.

d. Using the channel A POSITION control, exactly center the displayed pulse. (1/2 division above and below the center graticule line.)

- e. Change Time Base TRIGGER coupling to DC.
- f. Adjust channel A Sync Balance control, A2R7, to obtain a stable display.
- g. Check, by changing TRIGGER coupling from DC to AC several times. The display should remain synchronized.
- h. Disconnect the CALIBRATOR from channel A INPUT.

5-31. CHANNEL A OFFSET.

- a. Set controls as follows:

Time Base:

MODE AUTO

Model 1830A:

DISPLAY A
 VOLTS/DIV, channel A 01
 SYNC CH A

- b. Connect a short circuit to channel A INPUT.
- c. Adjust channel A POSITION control to exactly center the displayed sweep on the center graticule line.
- d. Remove short circuit from channel A INPUT.
- e. Adjust the channel A Offset control, A2R9, to exactly center the displayed sweep.
- f. Rotate channel A VOLTS/DIV control through all positions. The trace should remain centered for each position.

5-32. BEAM FINDER BALANCE.

- a. Set controls as follows:

Time Base:

MODE AUTO

Model 1830A:

DISPLAY A
 VOLTS/DIV, Channel A 01
 SYNC CH A

- b. Adjust channel A POSITION control to exactly center the displayed sweep on center graticule line,

- c. Press oscilloscope FIND BEAM and hold depressed.
- d. Adjust Beam Find Bal A5R61 to center displayed sweep.
- e. Release oscilloscope FIND BEAM.
- f. Note position of displayed sweep. Sweep should remain centered on graticule line. If sweep moves when FIND BEAM is released, repeat steps b through e until sweep remains exactly centered when FIND BEAM is depressed or released.

5-33. OUTPUT AMPLIFIER BALANCE.

- a. Set controls as follows:

DISPLAY B
 VOLTS/DIV, channel B 1

- b. While alternately changing channel B polarity selection switch between +UP and -UP, adjust channel B POSITION control to setting where no trace shift occurs.
- c. Adjust Amplifier Zero Balance control, A5R3, to exactly center the displayed sweep on the center graticule line.

5-34. CHANNEL B OFFSET.

- a. Set controls as follows:

DISPLAY B
 VOLTS/DIV, channel B 01
 SYNC COMP
 Channel B OFF/Polarity +UP

- b. Adjust the channel B Offset control, A2R34, to exactly center the displayed sweep on the center graticule line.
- c. Rotate the channel B VOLTS/DIV control through all positions. The trace should remain centered for each position.

5-35. COMPOSITE BALANCE.

- a. Set controls as follows:

Time Base:

INT/EXT INT
 AC/DC AC
 SWEEP TIME/DIV 0.5 MSEC

Model 1830A

Model 1830A:

DISPLAY B
SYNC COMP
VOLTS/DIV, channel B 0.5

Model 183A/B Oscilloscope:

CALIBRATOR AMP 0.5V
CALIBRATOR FREQ 2 kHz

b. Connect the CALIBRATOR OUT to channel B INPUT.

c. Adjust Time Base TRIGGER LEVEL for a stable display, centering it in the range which results in a stable display.

d. Using the channel B POSITION control, exactly center the displayed pulse. (1/2 division above and below the center graticule line.)

e. Change Time Base TRIGGER coupling to DC.

f. Adjust Composite Sync Balance control, A2R16, to obtain a stable display.

g. Check, by changing TRIGGER coupling from DC to AC several times. The display should remain synchronized.

5-36. HIGH FREQUENCY COMPENSATION.

a. Set controls as follows:

Time Base:

INT/EXT INT
TIME/DIV 01 μ SEC
NEG/POS NEG

Model 1830A:

DISPLAY A
SYNC CH A
VOLTS/DIV, channel A 0.1

Model 183A/B Oscilloscope:

CALIBRATOR OUT 0.5V
CALIBRATOR FREQ 1 MHz

b. Connect CALIBRATOR OUT to channel A INPUT using a short length of 50-ohm cable.

c. Adjust Time Base TRIGGER LEVEL for a stable display.

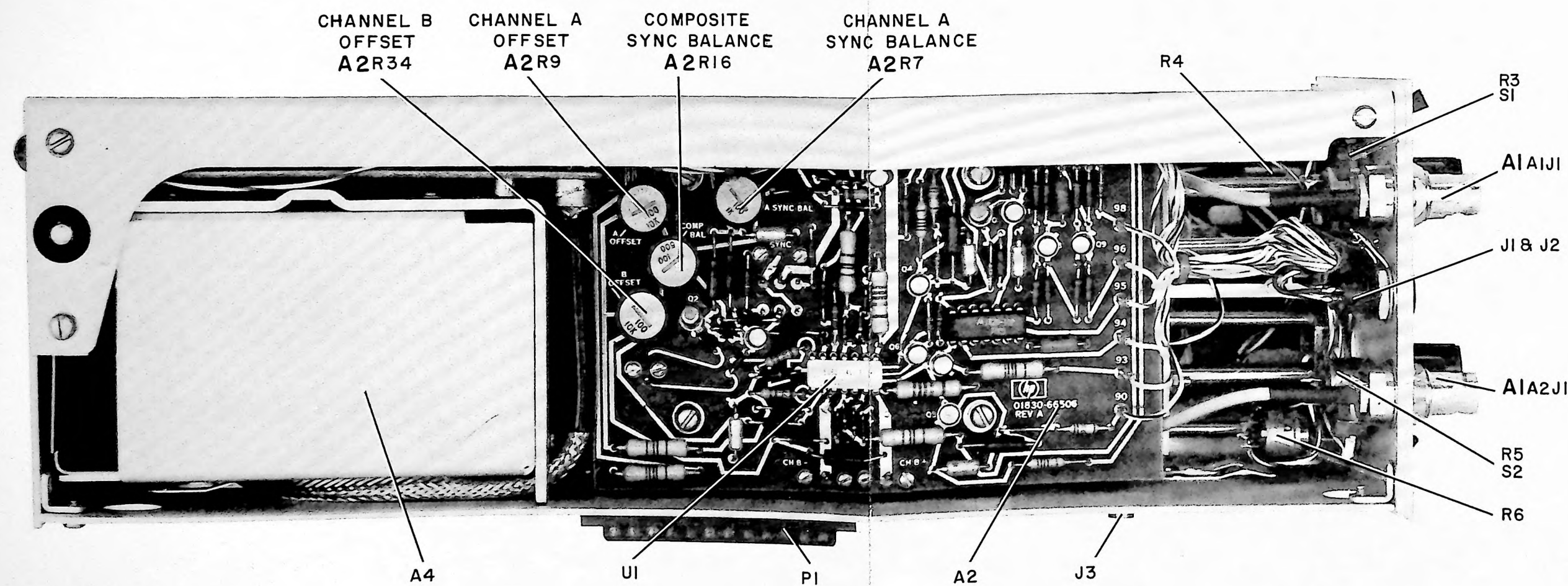
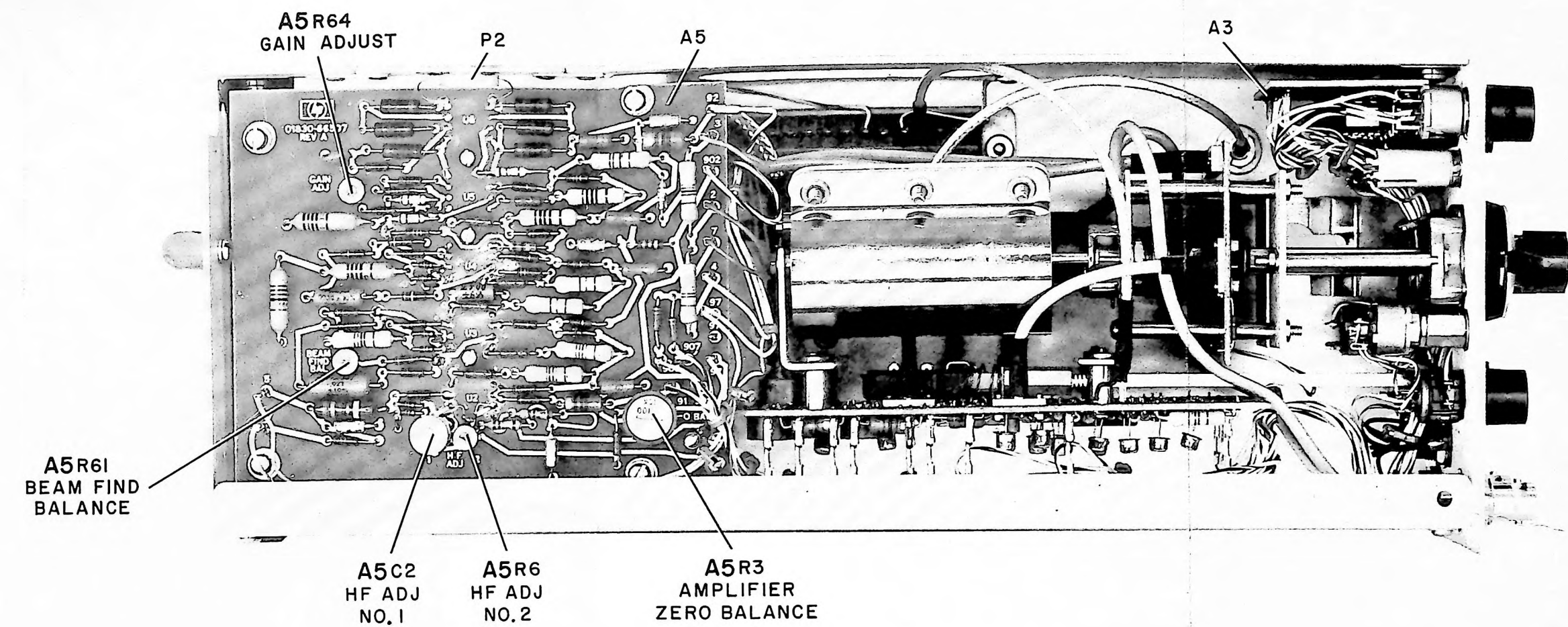
d. If desired, center the leading edge of the displayed pulse with HORIZONTAL POS control to obtain a better display of the leading edge and vertically center pulse with channel A POSITION control. Do NOT vertically center the top of the pulse, since this will result in overloading.

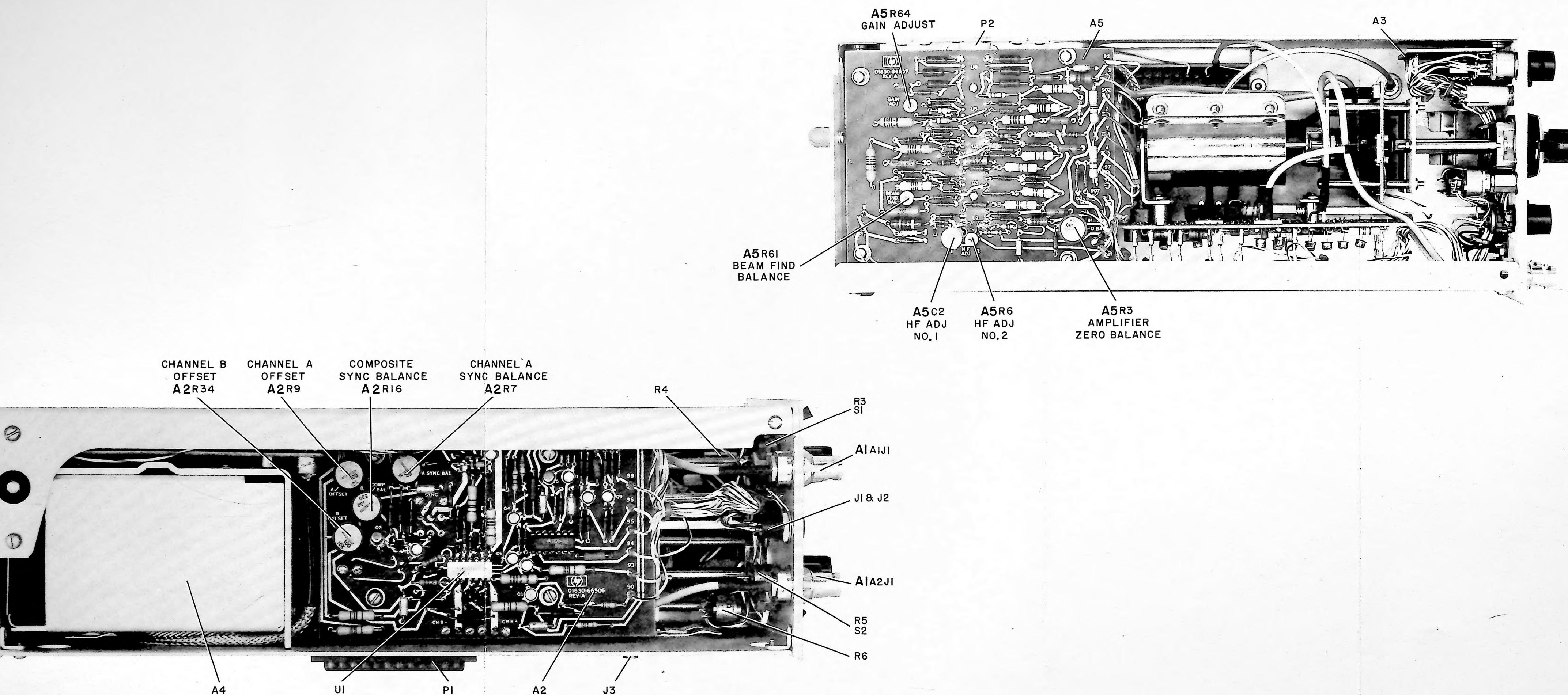
e. Adjust HF Adjustment No. 1 control, A5C2, for minimum overshoot of leading edge of the pulse, setting the level of the leading edge of the top of the pulse.

f. Adjust HF Adjustment No. 2, A5R6, for minimum ringing.

g. Repeat steps e and f to obtain the sharpest corner of the leading edge with the least amount of overshoot or ringing.

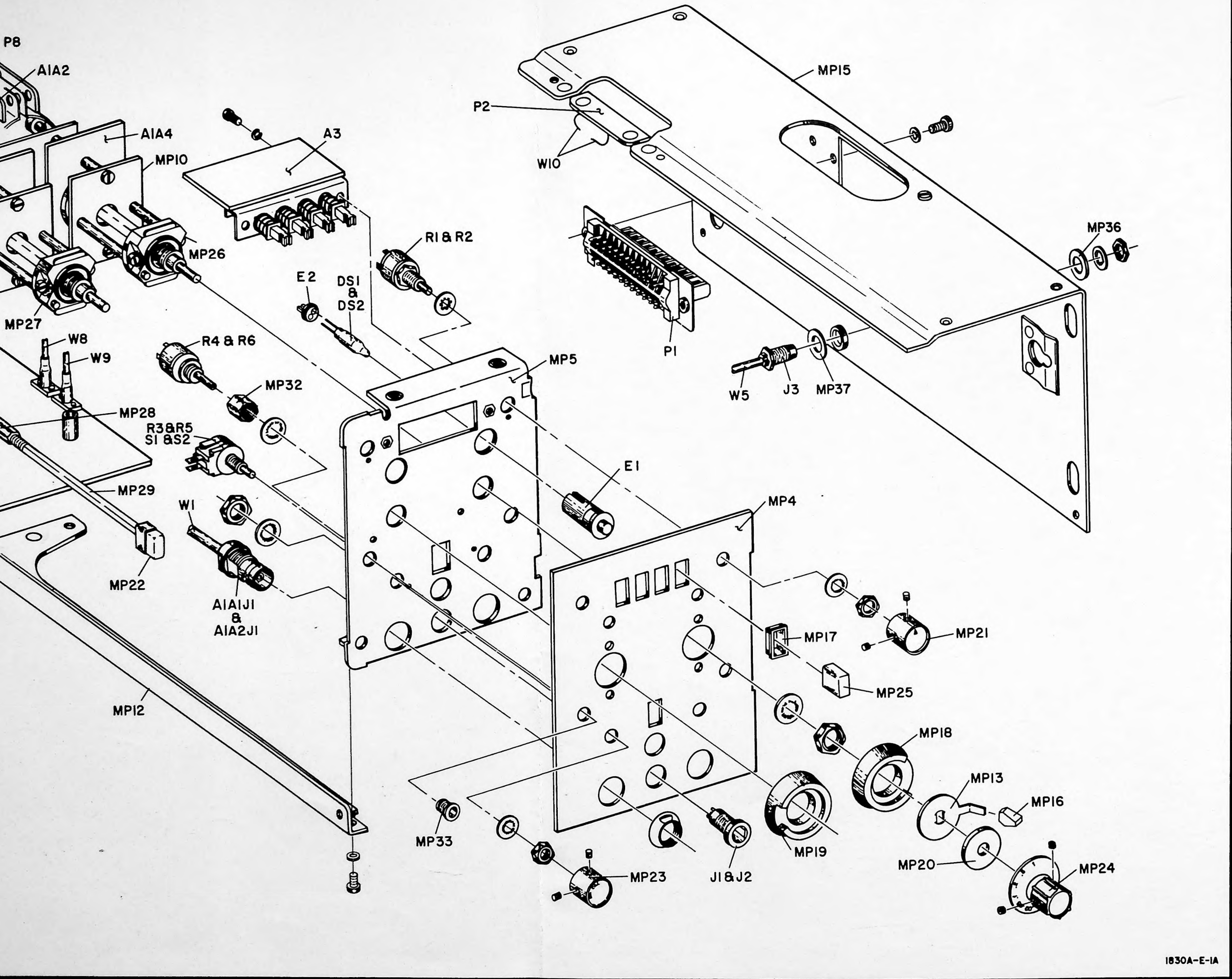
5-37. This completes the adjustment procedure. If desired, the instrument may be tested to Model 1830A specifications using the Performance Check procedure. If satisfactory adjustment or instrument performance is not obtained, refer to Section VIII of this manual for troubleshooting information.





1830A-C-5A

Figure 5-3.
Adjustment Location
5-11



1830A-E-1A

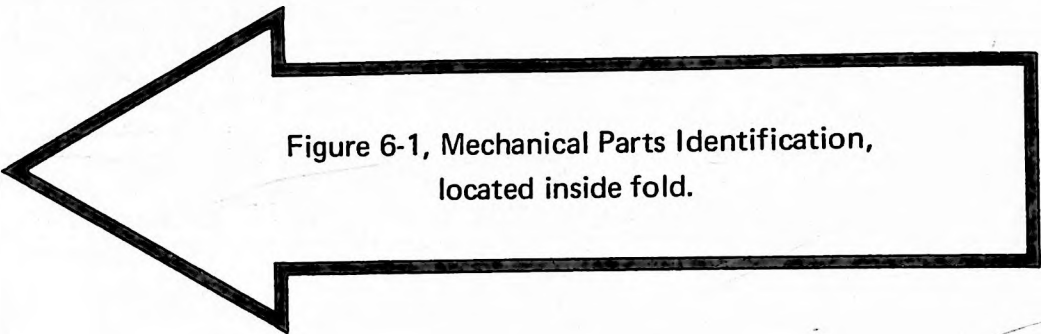


Figure 6-1, Mechanical Parts Identification,
located inside fold.

Table 6-1. Abbreviations for Replaceable Parts List

A	= ampere(s)	GRD	= ground(ed)	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage
ASSY	= assembly	H	= henry(ies)	NPN	= negative-positive-negative	S-B	= slow-blow
BD	= board(s)	HG	= mercury	NSR	= not separately replaceable	SCR	= silicon controlled rectifier
BH	= binder head	HP	= Hewlett-Packard	OBD	= order by description	SE	= selenium
BP	= bandpass	HZ	= hertz	OH	= oval head	SEC	= second(s)
				OX	= oxide	SECT	= section(s)
C	= centi (10 ⁻²)	IF	= intermediate freq.	P	= peak	SI	= silicon
CAR	= carbon	IMPG	= impregnated	PC	= printed (etched) circuit(s)	SIL	= silver
CCW	= counterclockwise	INCD	= incandescent	PHL	= picofarads	SI	= slide
CER	= ceramic	INCL	= include(s)	PIV	= peak inverse voltage(s)	SP	= single pole
CMO	= cabinet mount only	INS	= insulation(ed)	PNP	= positive-negative-positive	SPL	= special
COAX	= coaxial	INT	= internal	P/O	= part of	ST	= single throw
COEF	= coefficient	K	= kilo (10 ³)	PORC	= porcelain	STD	= standard
COMP	= composition	KG	= kilogram	POS	= position(s)		
CONN	= connector(s)	LB	= pound(s)	POT	= potentiometer(s)	TA	= tantalum
CRT	= cathode-ray tube	LH	= left hand	P-P	= peak-to-peak	TD	= time delay
CW	= clockwise	LIN	= linear taper	PRGM	= program	TFL	= teflon
		LOG	= logarithmic taper	PS	= polystyrene	TGL	= toggle
		LPF	= low-pass filter(s)	PWV	= peak working voltage	THYR	= thyristor
		LVR	= lever			TI	= titanium
ELECT	= electrolytic	M	= milli (10 ⁻³)	RECT	= rectifier(s)	TNLDIO	= tunnel diode(s)
ENCAP	= encapsulated	MEG	= mega (10 ⁶)	RF	= radio frequency	TOL	= tolerance
EXT	= external	MET FILM	= metal film	RFI	= radio frequency interference	TRIM	= trimmer
		MET OX	= metal oxide	RH	= round head or right hand	U	= micro (10 ⁻⁶)
F	= farad(s)	MFR	= manufacturer			V	= volts
FET	= field-effect transistor(s)	MINAT	= miniature			VAR	= variable
FH	= flat head	MOM	= momentary			VDCW	= dc working volt(s)
FIL H	= fillister head	MTG	= mounting				
FXD	= fixed	MY	= mylar			W	= watt(s)
		N	= nano (10 ⁻⁹)			W/	= with
G	= giga (10 ⁹)	N/C	= normally closed			WIV	= working inverse voltage
GE	= germanium	NE	= neon			W/O	= without
GL	= glass	N/O	= normally open			WW	= wirewound
				RMO	= rack mount only		
				RMS	= root mean square		

Figure 6-1. Mechanical Parts Identification

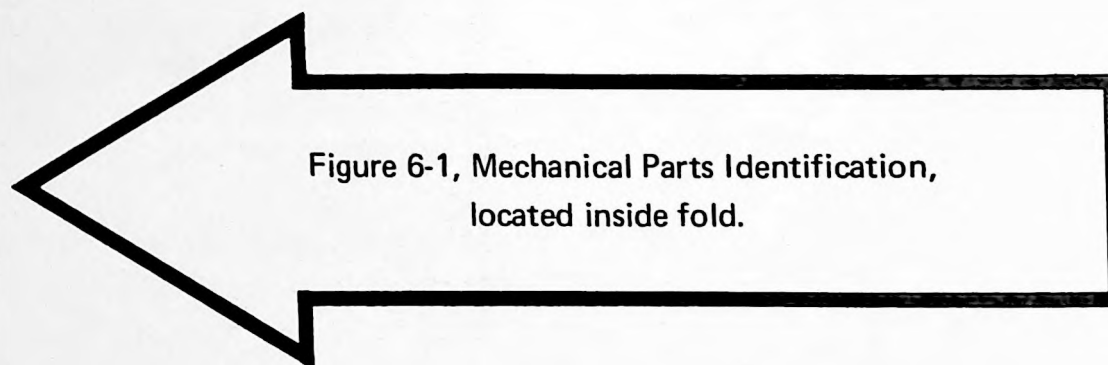


Table 6-1. Abbreviations for Replaceable Parts List

A	= ampere(s)	GRD	= ground(ed)	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage
ASSY	= assembly						
BD	= board(s)	H	= henry(ies)	NPN	= negative-positive-negative	S-B	= slow-blow
BH	= binder head	HG	= mercury	NSR	= not separately replaceable	SCR	= silicon controlled rectifier
BP	= bandpass	HP	= Hewlett-Packard			SE	= selenium
		HZ	= hertz			SEC	= second(s)
C	= centi (10^{-2})	IF	= intermediate freq.	OBD	= order by description	SECT	= section(s)
CAR	= carbon	IMPG	= impregnated	OH	= oval head	SI	= silicon
CCW	= counterclockwise	INCD	= incandescent	OX	= oxide	SIL	= silver
CER	= ceramic	INCL	= include(s)			SI	= slide
CMO	= cabinet mount only	INS	= insulation(ed)	P	= peak	SP	= single pole
COAX	= coaxial	INT	= internal	PC	= printed (etched) circuit(s)	SPL	= special
COEF	= coefficient			PF	= picofarads	ST	= single throw
COMP	= composition	K	= kilo (10^3)	PHL	= Phillips	STD	= standard
CONN	= connector(s)	KG	= kilogram	PIV	= peak inverse voltage(s)		
CRT	= cathode-ray tube			PNP	= positive-negative-positive	TA	= tantalum
CW	= clockwise	LB	= pound(s)	P/O	= part of	TD	= time delay
D	= deci (10^{-1})	LH	= left hand	PORC	= porcelain	TFL	= teflon
DEPC	= deposited carbon	LIN	= linear taper	POS	= position(s)	TGL	= toggle
DP	= double pole	LOG	= logarithmic taper	POT	= potentiometer(s)	THYR	= thyristor
DT	= double throw	LPF	= low-pass filter(s)	P-P	= peak-to-peak	TI	= titanium
		LVR	= lever	PRGM	= program	TNLDIO	= tunnel diode(s)
ELECT	= electrolytic			PS	= polystyrene	TOL	= tolerance
ENCAP	= encapsulated	M	= milli (10^{-3})	PWV	= peak working voltage	TRIM	= trimmer
EXT	= external	MEG	= mega (10^6)			U	= micro (10^{-6})
		MET FILM	= metal film	RECT	= rectifier(s)	V	= volts
F	= farad(s)	MET OX	= metal oxide	RF	= radio frequency	VAR	= variable
FET	= field-effect transistor(s)	MFR	= manufacturer	RFI	= radio frequency interference	VDCW	= dc working volt(s)
FH	= flat head	MINAT	= miniature	RH	= round head or right hand	W	= watt(s)
FIL H	= fillister head	MOM	= momentary			W/	= with
FXD	= fixed	MTG	= mounting	RMO	= rack mount only	WIV	= working inverse voltage
		MY	= mylar	RMS	= root mean square	W/O	= without
G	= giga (10^9)	N	= nano (10^{-9})			WW	= wirewound
GE	= germanium	N/C	= normally closed				
GL	= glass	NE	= neon				
		N/O	= normally open				

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. The abbreviations used in the parts list are described in Table 6-1. Table 6-2 lists the parts in alphanumeric order by reference designator and includes the manufacturer and manufacturer's part number. Table 6-3 contains the list of manufacturer's codes.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts from Hewlett-Packard, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office and supply the following information.

- a. Instrument model and serial number.
- b. HP Part Number of item(s).
- c. Quantity of part(s) desired.
- d. Reference designator of part(s).

6-5. To order a part not listed in the table, provide the following information:

- a. Instrument model and serial number.
- b. Description of the part, including function and location in the instrument.
- c. Quantity desired.

6-6. A2 and A5 REPLACEMENT.

6-7. A2. The Preamplifier assembly, A2, requires an integrated circuit, U1, which must also be ordered if a complete replacement assembly is desired. U1 is a plug-in component and is listed in Table 6-2 under Chassis Parts.

6-8. A5. The part number etched on the circuit board for Output Amplifier assembly A5 does not correspond to the HP Part No. listed in this manual. Be sure to order the assembly by the part number given in the replaceable parts list.

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	01830-61901	1	A1 ASSY: SIGNAL CONDITIONING CONSISTS OF A1A1, A1A2, A1A3, A1A4, MP10 MP11, MP26, MP27, W7, W8, W9.	28480	01830-61901
A1A1	01830-61902		A1A1 ATTENUATOR ASSY "A" (INCLUDES MP7, MP8, MP34) N.S.R. PART OF W1	28480	01830-61902
A1A1J1					
A1A1R1	0698-6790	8	R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A1R2	0698-6792	2	R:FXD FLM 37.5 OHM 0.5% 1/4W	28480	0698-6792
A1A1R3	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A1R4	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A1R5	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A1R6	0698-6791	2	R:FXD FLM 120 OHM 0.5% 1/4W	28480	0698-6791
A1A1R7	0698-5195	2	R:FXD MET FLM 75 OHM 0.5% 1/8W	28480	0698-5195
A1A1R8	0698-6794	4	R:FXD FLM 61.1 OHM 0.5% 1/8W	28480	0698-6794
A1A1R9	0698-6793	2	R:FXD FLM 248 OHM 0.5% 1/8W	28480	0698-6793
A1A1R10	0698-6794		R:FXD FLM 61.1 OHM 0.5% 1/8W	28480	0698-6794
A1A1S1	3100-2534	2	SWITCH: ROTARY	28480	3100-2534
A1A1W1	01830-61605	2	CABLE: ATTENUATOR INPUT (INCLUDES A1A1J1)	28480	01830-61605
A1A1W2	01830-61602	2	CABLE: ATTENUATOR OUTPUT	28480	01830-61602
A1A2	01830-61902		A1A2 ATTENUATOR ASSY "B" (INCLUDES MP7, MP8, MP34) N.S.R. PART OF W1	28480	01830-61902
A1A2J1					
A1A2R1	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A2R2	0698-6792		R:FXD FLM 37.5 OHM 0.5% 1/4W	28480	0698-6792
A1A2R3	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A2R4	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A2R5	0698-6790		R:FXD FLM 150 OHM 0.5% 1/4W	28480	0698-6790
A1A2R6	0698-6791		R:FXD FLM 120 OHM 0.5% 1/4W	28480	0698-6791
A1A2R7	0698-5195		R:FXD MET FLM 75 OHM 0.5% 1/8W	28480	0698-5195
A1A2R8	0698-6794		R:FXD FLM 61.1 OHM 0.5% 1/8W	28480	0698-6794
A1A2R9	0698-6793		R:FXD FLM 248 OHM 0.5% 1/8W	28480	0698-6793
A1A2R10	0698-6794		R:FXD FLM 61.1 OHM 0.5% 1/8W	28480	0698-6794
A1A2S1	3100-2534		SWITCH: ROTARY	28480	3100-2534
A1A2W1	01830-61605		CABLE: ATTENUATOR INPUT (INCLUDES A1A2J1)	28480	01830-61605
A1A2W2	01830-61602		CABLE: ATTENUATOR OUTPUT	28480	01830-61602
A1A3	01830-61903		A1A3 SWITCH ASSY: CHANNEL "A"	28480	01830-61903
A1A3R1	0698-5965	2	R:FXD MET FLM 50 OHM 1.0% 1/2W	28480	0698-5965
A1A3R2	0757-0394	9	R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A1A3S1			N.S.R. PART OF A1A3		
A1A4	01830-61904		A1A4 SWITCH ASSY: CHANNEL "B"	28480	01830-61904
A1A4R1	0757-0273	7	R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A1A4R2	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A1A4R3	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A1A4R4	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A1A4R5	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A1A4R6	0698-5965		R:FXD MET FLM 50 OHM 1.0% 1/2W	28480	0698-5965
A1A4S1			N.S.R. PART OF A1A4		
A2	01830-66506	1	A2 BOARD ASSY: PREAMPLIFIER	28480	01830-66506
A2C1	0160-0153	7	C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A2C2	0160-3567	4	C:FXD CER 10.0 PF 5% 100VDCW	72982	8101-100-COG-100J
A2C3	0160-3567		C:FXD CER 10.0 PF 5% 100VDCW	72982	8101-100-COG-100J
A2C4	0180-0230	10	C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A2C5	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A2C6	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A2C7	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A2C8	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A2C9	0160-3567		C:FXD CER 10.0 PF 5% 100VDCW	72982	8101-100-COG-100J
A2C10	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2C11	0160-3567	2	C:FXD CER 10.0 PF 5% 100VDCW	72982	8101-100-COG-100J
A2C12	0160-3565		C:FXD CER 6.8 PF 100VDCW	72982	8101-100-COG-689J
A2C13	0160-3568	1	C:FXD CER 2.7 PF 5% 100VDCW	72982	8101-100-COG-279J
	0160-2247		C: FXD CER 39 PF $\pm$.25 PF 500 WVDC	72982	301-000-COJ0-399C
	0160-2248		C: FXD CER 4.3 PF $\pm$.25 PF 500 WVDC	72982	301-000-COHO-439C
	0160-2249		C: FXD CER 4.7 PF $\pm$.25PF 500 WVDC	72982	301-000-COHO-479C
A2C14			NOT ASSIGNED		
A2C15	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A2C16	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A2C17	0160-3619	1	C:FXD CER 680 PF 10% 100VDCW	28480	0160-3619
A2C18	0160-3647	4	C: FXD CER 22 PF 100 VDCW	28480	0160-3647
A2CR1			NSR, P/O A2Q1		
A2CR2	1901-0179		DIODE:SILICON 15WV	28480	1901-0179
A2CR3	1901-0179		DIODE:SILICON 15WV	28480	1901-0179
A2CR4	1901-0179		DIODE:SILICON 15WV	28480	1901-0179
A2CR5	1901-0040	5	DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR7	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR8	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2E5	5020-0495	28	PIN:SQUARE	28480	5020-0495
A2L1	9170-0016	1	BEAD:MAGNETIC SHIELDING	02114	56-590-65/38
A2L2	9140-0210	3	COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A2L3	9140-0096	1	COIL:FXD RF 1 UH	28480	9140-0096
A2Q1	5080-9656	1	TSTR/DIODE MATCHED SET (INCLUDES A2CR1)	28480	5080-9656
A2Q2	1853-0061	2	TSTR:SI PNP	28480	1853-0061
A2Q3	1853-0061		TSTR:SI PNP	28480	1853-0061
A2Q4	1853-0203	4	TSTR:SI PNP	28480	1853-0203
A2Q5	1853-0203		TSTR:SI PNP	28480	1853-0203
A2Q6	1853-0203		TSTR:SI PNP	28480	1853-0203
A2Q7	1853-0203		TSTR:SI PNP	28480	1853-0203
A2Q8	1854-0009	4	TSTR:SI NPN	80131	2N709
A2Q9	1854-0009		TSTR:SI NPN	80131	2N709
A2Q10	1854-0009		TSTR:SI NPN	80131	2N709
A2Q11	1854-0009		TSTR:SI NPN	80131	2N709
A2R1	0757-1000	3	R:FXD MET FLM 51.1 OHM 1% 1/2W	28480	0757-1000
A2R2	0757-1000		R:FXD MET FLM 51.1 OHM 1% 1/2W	28480	0757-1000
A2R3	0757-1000		R:FXD MET FLM 51.1 OHM 1% 1/2W	28480	0757-1000
A2R4	0757-0413	2	R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A2R5	0757-0420	2	R:FXD MET FLM 750 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R6	0757-0280	8	R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R7	2100-1773	1	R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A2R8	0757-0449	2	R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A2R9	2100-1776	3	R:VAR WW 10K OHM 5% TYPE H 1W	28480	2100-1776
A2R10	0757-0811	2	R:FXD MET FLM 392 OHM 1% 1/2W	28480	0757-0811
A2R11	0698-7196	4	R:FXD FLM 21.5 OHM 2% 1/8W	28480	0698-7196
A2R12	0698-7196		R:FXD FLM 21.5 OHM 2% 1/8W	28480	0698-7196
A2R13	0698-7212	5	R:FXD FLM 100 OHM 2% 1/8W	28480	0698-7212
A2R14	0757-0273		R: FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A2R15	0698-3432	1	R:FXD MET FLM 26.1 OHM 1% 1/8W	28480	0698-3432
A2R16	2100-1772	1	R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A2R17	0757-0420		R: FXD METFLM 750 OHM 1% 1/8W	28480	0757-0420
A2R18	0757-0407	3	R:FXD MET FLM 200 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R19	0757-0338	2	R:FXD MET FLM 1.00K OHM 1% 1/4W	28480	0757-0338
A2R20	0757-0338		R:FXD MET FLM 1.00K OHM 1% 1/4W	28480	0757-0338
A2R21	0698-7203	1	R:FXD FLM 42.2 OHM 2% 1/8W	28480	0698-7203
A2R22	0698-7212		R:FXD FLM 100 OHM 2% 1/8W	28480	0698-7212
A2R23	0698-7212		R:FXD FLM 100 OHM 2% 1/8W	28480	0698-7212
A2R24	0757-0397	4	R:FXD MET FLM 68.1 OHM 1% 1/8W	19701	MF4C T-0
A2R25	0757-0397		R:FXD MET FLM 68.1 OHM 1% 1/8W	19701	MF4C T-0
A2R26	0698-7212		R:FXD FLM 100 OHM 2% 1/8W	28480	0698-7212
	0698-7203		R: FXD FLM 42.2 OHM 2% 1/8W	14674	0698-7203 C3
A2R27	0698-7196		R:FXD FLM 21.5 OHM 2% 1/8W	28480	0698-7196
A2R28	0698-7196		R:FXD FLM 21.5 OHM 2% 1/8W	28480	0698-7196
A2R29	0757-0811		R:FXD MET FLM 392 OHM 1% 1/2W	28480	0757-0811
A2R30	0757-0760	1	R:FXD FLM 20K OHM 1% 1/4W	28480	0757-0760
A2R31	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R32	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R33	0757-0449		R:FXD FLM 20K OHM 1% 1/8W	28480	0757-0449
A2R34	2100-1776		R:VAR WW 10K OHM 5% TYPE H 1W	28480	2100-1776
A2R35	0757-0283	2	R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A2R36	0757-0442	3	R:FXD MET FLM 10.0K 1% 1/8W	14674	ORDER BY DESCRIPTION

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R38	0757-0806	2	R:FXD MET FLM 243 OHM 1% 1/8W	28480	0757-0806
A2R39	0757-0808	2	R:FXD MET FLM 301 OHM 1% 1/4W	28480	0757-0808
A2R40	0698-3431	4	R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A2R41	0757-0747	2	R:FXD FLM 5110 OHM 1% 1/4W	28480	0757-0747
A2R42	0757-0334	2	R:FXD MET FLM 301 OHM 1% 1/4W	28480	0757-0334
A2R43	0757-0416	2	R:FXD MET FLM 511 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R44	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A2R45	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R46	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A2R47	0757-0427	2	R:FXD MET FLM 1.5K 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R48	0757-0439	2	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A2R49	0757-0439		R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A2R50	0757-0427		R:FXD MET FLM 1.5K 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R51	0757-0808		R:FXD MET FLM 301 OHM 1% 1/4W	28480	0757-0808
A2R52	0698-3431		R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A2R53	0757-0747		R:FXD FLM 5110 OHM 1% 1/4W	28480	0757-0747
A2R54	0757-0334		R:FXD MET FLM 301 OHM 1% 1/4W	28480	0757-0334
A2R55	0757-0806		R:FXD MET FLM 243 OHM 1% 1/8W	28480	0757-0806
A2R56	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A2R57	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R58	0757-0401	1	R:FXD MET FLM 100 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R59	0757-0438	1	R:FXD MET FLM 5.11K 1% 1/8W	14674	ORDER BY DESCRIPTION
A2R60	0698-7212		R:FXD FLM 100 OHM 2% 1/8W	28480	0698-7212
A2S1	3101-1285	1	SWITCH:PUSHBUTTON 2P SINGLE STATION	71590	PB-1
A2U1	1820-0102	1	INTEGRATED CIRCUIT:J-K FLIP FLOP	04713	MC1013P
A2VR1	1902-0041	2	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98
A2VR2	1902-0126	1	DIODE:BREAKDOWN 2.61V 5%	04713	SZ10939-14
A2VR3	1902-0041	1	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-93
A3	01830-66501		A3 ASSY: DISPLAY MODE (INCLUDES CIRCUIT BOARD)	28480	01830-66501
A4	01830-61610		A4 ASSY: DELAY LINE (INCLUDES MP3, MP6, MP14)	28480	01830-61610

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			A5		
A5	01830-69502	1	BOARD ASSY:OUTPUT AMPLIFIER	28480	01830-69502
A5C1	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D1C5X0050A2-DYS
A5C2	0121-0060	5	C:VAR CER 2-8 NPO	72982	538-011-COPD-89R
A5C3	0160-3565		C:FXD CER 6.8 PF 100VDCW	72982	8101-100-COG-689J
A5C4	0160-3566	4	C:FXD CER 5.6 PF 100VDCW	72982	8101-100-COG-569J
A5C5	0160-0162	1	C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A5C6	0160-3566		C:FXD CER 5.6 PF 100VDCW	72982	8101-100-COG-569J
A5C7	0160-0156	1	C:FXD MY 0.0039 UF 10% 200VDCW	56289	192P39292-PTS
A5C8	0160-3647		C:FXD CER 22 PF 100VDCW	28480	0160-3647
A5C9	0160-3566		C:FXD CER 5.6 PF 100VDCW	72982	8101-100-COG-569J
A5C10	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A5C11	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A5C12	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A5C13	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A5C14	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A5C15	0180-0230		C:FXD ELECT 1.0 UF 20% 50VDCW	56289	150D105X0050A2-DYS
A5C16	0160-0153		C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PTS
A5C17	0150-0050	1	C:FXD CER DISC 1000 PF +80-20% 1000VDCW	56289	C067B102E102ZE19-CDH
A5C18	0160-3566		C:FXD CER 5.6 PF 100VDCW	72982	8101-100-COG-569J
	0160-3568		FACTORY SELECTED PART		
			C: FXD CER 2.7 PF 5% 100 WVDC	72982	8101-100-COG-279J
			FACTORY SELECTED PART		
A5C19	0160-3647		C: FXD CER 22 PF 100 VDCW	28480	0160-3647
A5C20	0160-3647		C: FXD CER 22 PF 100 VDCW	28480	0160-3647
A5CR1	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5E3	0363-0040	1	CONTACT:LEAF SPRING	30817	97-500-CDG
A5E4	0360-1560	1	TERMINAL PIN: RIGHT ANGLE	28480	0360-1560
A5E5	5020-0495		PIN:SQUARE	28480	5020-0495
A5L1	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A5L2	9100-3117	1	COIL:2700 UH	28480	9100-3117
A5L3	9100-2281	1	COIL:FXD 270 UH 10%	82142	09-A271K
A5L4	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A5R1	0757-0410	1	R:FXD MET FLM 301 OHM 1% 1/8W	28480	0757-0410
A5R2	0757-0442		R:FXD MET FLM 10.0K 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R3	2100-1776		R:VAR WW 10K OHM 5% TYPE H 1W	28480	2100-1776
A5R4	0757-0397		R:FXD MET FLM 68.1 OHM 1% 1/8W	19701	MF4C T-0
	0757-0398	2	FACTORY SELECTED PART	28480	0757-0398
A5R5	0757-0397		R:FXD MET FLM 75 OHM 1% 1/8W	19701	MF4C T-0
	0757-0398		FACTORY SELECTED PART		
			R:FXD MET FLM 68.1 OHM 1% 1/8W	28480	0757-0398
	0757-0398		FACTORY SELECTED PART		
A5R6	2100-1984	1	R:VAR FLM 100 OHM 10% LIN 1/2W	28480	2100-1984
A5R7	0698-7197	2	R:FXD FLM 23.7 OHM 2% 1/8W	28480	0698-7197
A5R8	0698-7197		R:FXD FLM 23.7 OHM 2% 1/8W	28480	0698-7197
A5R9	0761-0052	1	R:FXD MET OX 270 OHM 5% 1W	28480	0761-0052
A5R10	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R11	0757-0419	1	R:FXD MET FLM 681 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R12	0757-0796	4	R:FXD MET FLM 82.5 OHM 1% 1/2W	28480	0757-0796
	0757-0795		FACTORY SELECTED PART		
			R: FXD MET FLM 75 OHM 1% 1/2W	28480	0757-0795
	0757-0797		FACTORY SELECTED PART		
			R: FXD MET FLM 90.9 OHM 1% 1/2W	28480	0757-0797
			FACTORY SELECTED PART		
A5R13	0757-0796		R:FXD MET FLM 82.5 OHM 1% 1/2W	28480	0757-0796
	0757-0795		FACTORY SELECTED PART		
			R: FXD MET FLM 75 OHM 1% 1/2W	28480	0757-0795
	0757-0797		FACTORY SELECTED PART		
			R: FXD MET FLM 90.9 OHM 1% 1/2W	28480	0757-0797
			FACTORY SELECTED PART		
A5R14	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R15	0757-0426	1	R:FXD FLM 1.3K OHM 1% 1/8W	28480	0757-0426
A5R16	0698-7199	4	R:FXD FLM 28.7 OHM 2% 1/8W	28480	0698-7199
A5R17	0698-7199		R:FXD FLM 28.7 OHM 2% 1/8W	28480	0698-7199
A5R18	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R19	0757-0801	1	R:FXD MET FLM 150 OHM 1% 1/2W	28480	0757-0801
A5R20	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R21	0757-0796		R:FXD MET FLM 82.5 OHM 1% 1/2W	28480	0757-0796
	0757-0795		FACTORY SELECTED PART		
			R: FXD MET FLM 75 OHM 1% 1/2W	28480	0757-0795
	0757-0797		FACTORY SELECTED PART		
			R: FXD MET FLM 90.9 OHM 1% 1/2W	28480	0757-0797
			FACTORY SELECTED PART		
A5R22	0757-0434	2	R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A5R23	0757-0796		R:FXD MET FLM 82.5 OHM 1% 1/2W	28480	0757-0796
	0757-0795		FACTORY SELECTED PART		
			R: FXD MET FLM 75 OHM 1% 1/2W	28480	0757-0795
	0757-0797		FACTORY SELECTED PART		
			R: FXD MET FLM 90.9 OHM 1% 1/2W	28480	0757-0797
			FACTORY SELECTED PART		

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R24	0757-0417	1	R:FXD MET FLM 562 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R25	0757-0413		R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A5R26	0757-0418	1	R:FXD MET FLM 619 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R27	0698-7199		R:FXD FLM 28.7 OHM 2% 1/8W	28480	0698-7199
A5R28	0698-7199		R:FXD FLM 28.7 OHM 2% 1/8W	28480	0698-7199
A5R29	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R30	0757-0799	2	R:FXD MET FLM 121 OHM 1% 1/2W	28480	0757-0799
A5R31	0757-0799		R:FXD MET FLM 121 OHM 1% 1/2W	28480	0757-0799
A5R32	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R33	0757-0434		R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A5R34	0757-0178	2	R:FXD MET FLM 100 OHM 1% 1/4W	19701	MF52C
A5R35	0757-0178		R:FXD MET FLM 100 OHM 1% 1/4W	19701	MF52C
A5R36	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R37	0757-0391	2	R:FXD FLM 39.2 OHM 1% 1/8W	28480	0757-0391
A5R38	0757-0391		R:FXD FLM 39.2 OHM 1% 1/8W	28480	0757-0391
A5R39	0757-0394		R:FXD MET FLM 51.1 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R40	0757-0198	2	R:FXD MET FLM 100 OHM 1% 1/2W	28480	0757-0198
A5R41	0757-0198		R:FXD MET FLM 100 OHM 1% 1/2W	28480	0757-0198
A5R42	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R43	0757-0726	4	R:FXD MET FLM 511 OHM 1% 1/4W	28480	0757-0726
A5R44	0757-0726		R:FXD MET FLM 511 OHM 1% 1/4W	28480	0757-0726
A5R45	0757-0726		R:FXD MET FLM 511 OHM 1% 1/4W	28480	0757-0726
A5R46	0757-0726		R:FXD MET FLM 511 OHM 1% 1/4W	28480	0757-0726
A5R47	0698-3158	1	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A5R48	0698-3430	1	R:FXD MET FLM 21.5 OHM 1% 1/8W	28480	0698-3430
A5R49	0757-0382	1	R:FXD MET FLM 16.2 OHM 1% 1/8W	28480	0757-0382
A5R50	0757-0454	2	R:FXD MET FLM 33.2K OHM 1% 1/8W	28480	0757-0454
A5R51	0757-0454		R:FXD MET FLM 33.2K OHM 1% 1/8W	28480	0757-0454
A5R52	0698-3431		R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A5R53	0757-0823	1	R:FXD MET FLM 1.82K OHM 1% 1/2W	28480	0757-0823
A5R54	0698-3431		R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A5R55	0698-3402	1	R:FXD MET FLM 316 OHM 1% 1/2W	28480	0698-3402
A5R56	0698-3281	1	R:FXD MET FLM 26.1 OHM 1% 1/4W	28480	0698-3281
A5R57	0761-0038	1	R:FXD MET OX 5600 OHM 5% 1W	14674	ORDER BY DESCRIPTION
A5R58	0757-0834	1	R:FXD MET FLM 5.62K OHM 2% 1/2W	28480	0757-0834
A5R59	0684-0271	1	R:FXD COMP 2.7 OHM 10% 1/4W	01121	C8 27G1
A5R60	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A5R61	2100-2216	1	R:VAR FLM 5K OHM 10% LIN 1/2W	28480	2100-2216
A5R62	0757-0273		R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A5R63	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5R64	2100-2497	1	R:VAR FLM 2000 OHM 10% LIN 1/2W	28480	2100-2497
A5R65	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	14674	ORDER BY DESCRIPTION
A5U2	5060-0488	4	IC: SEALED PACKAGE (DRIVER)	28480	5060-0488
A5U3	5060-0488		IC: SEALED PACKAGE (DRIVER)	28480	5060-0488
A5U4	5060-0488		IC: SEALED PACKAGE (DRIVER)	28480	5060-0488
A5U5	5060-0488		IC: SEALED PACKAGE (DRIVER)	28480	5060-0488
A5U6	5060-0489	1	IC: SEALED PACKAGE (OUTPUT)	28480	5060-0489
A5VR1	1902-3249	1	DIODE BREAKDOWN:22.1V 2% 400 MW	28480	1902-3249
A5Z1	9100-3108	6	INDUCTOR: FXD (SPECIAL)	28480	9100-3108
A5Z2	9100-3108		INDUCTOR: FXD (SPECIAL)	28480	9100-3108
A5Z3	9100-3108		INDUCTOR: FXD (SPECIAL)	28480	9100-3108
A5Z4	9100-3108		INDUCTOR: FXD (SPECIAL)	28480	9100-3108
A5Z5	9100-3108		INDUCTOR: FXD (SPECIAL)	28480	9100-3108
A5Z6	9100-3108		INDUCTOR: FXD (SPECIAL)	28480	9100-3108

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CHASSIS PARTS		
DS1	2140-0018	2	LAMP:GLOW 1.0 MILLIAMPS 0.1W	08806	A9A-C (NE-2E1)
DS2	2140-0018		LAMP:GLOW 1.0 MILLIAMPS 0.1W	08806	A9A-C (NE-2E1)
E1	5060-0451	2	LENS ASSY	28480	5060-0451
E2	5060-0458	2	HEADER:LAMP	28480	5060-0458
E6	0362-0264	29	TERMINATION:CRIMP LUG	91886	2611225-14
J1	5060-0467	2	CONNECTOR: MALE PROBE POWER	28480	5060-0467
J2	5060-0467		CONNECTOR: MALE PROBE POWER	28480	5060-0467
J3	1250-1248	1	CONNECTOR:COAX, SYNC	28480	1250-1248
MP1	01830-00204	1	PANEL:LEFT REAR	28480	01830-00204
MP3	01830-00604	1	SHIELD:DELAY LINE	28480	01830-00604
MP4	01830-00201	1	PANEL:FRONT	28480	01830-00201
MP5	01830-00203	1	PANEL:SUB	28480	01830-00203
MP6	01830-01101	1	HEAT SINK:VERTICAL OUTPUT	28480	01830-01101
MP7	01830-01201	2	CLAMP:ATTENUATOR	28480	01830-01201
MP8	01830-01202	2	CLAMP:ATTENUATOR	28480	01830-01202
MP9	01830-01203	1	BRACKET:ATTENUATOR, REAR	28480	01830-01203
MP10	01830-01204	2	BRACKET:INPUT SWITCH	28480	01830-01204
MP11	01830-01205	1	BRACKET:ATTENUATOR, FRONT	28480	01830-01205
MP12	01830-04701	1	SUPPORT:PLUG-IN	28480	01830-04701
MP13	01830-05001	2	LEVER:INPUT SWITCH	28480	01830-05001
MP14	01830-05201	1	HOUSING:DELAY LINE	28480	01830-05201
MP15	01830-60101	1	CHASSIS:LEFT	28480	01830-60101
MP16	0370-0432	2	KNOB:BLACK LEVER	28480	0370-0432
MP17	0370-0451	5	BEZEL:PUSHBUTTON KNOB BLK NYLON	28480	0370-0451
MP18	0380-0890	1	SPACER: DIAL, RIGHT	28480	0380-0890
MP19	0380-0891	1	SPACER: DIAL, LEFT	28480	0380-0891
MP20	3050-0467	2	WASHER:FLAT, DELRIN FOR #12 HDW	00000	ORDER BY DESCRIPTION
MP21	00180-67402	2	KNOB ASSY:POSITION	28480	00180-67402
MP22	00183-67406	1	PUSHBUTTON	28480	00183-67406
MP23	01821-67403	2	KNOB ASSY:CAL	28480	01821-67403
MP24	01830-67401	2	KNOB ASSY:V/DIV	28480	01830-67401
MP25	01830-67402	4	PUSHBUTTON	28480	01830-67402
MP26	3100-2535	1	FRAME:SWITCH, RIGHT	28480	3100-2535
MP27	3100-2536	1	FRAME:SWITCH, LEFT	28480	3100-2536
MP28	01830-23201	1	COUPLER: SWITCH EXTENSION	28480	01830-23201
MP29	01830-23901	1	EXTENDER:SWITCH ACTUATING	28480	01830-23901
MP32	0590-0043	2	NUT:HEX 1/4 X 32 INTERNAL THREAD	00866	ORDER BY DESCRIPTION
MP33	1490-0848	2	BUSHING:POT 1/4-32 EXT THREAD(CAL)	00000	ORDER BY DESCRIPTION
MP34	01830-00603	2	SHIELD:ATTENUATOR	28480	01830-00603
MP35	01840-26101	1	PIN: LOCK OUT	28480	01840-26101
MP36	3050-0478	1	WASHER:FLAT METALLIC	00000	ORDER BY DESCRIPTION
MP37	3050-0479	1	WASHER:FLAT METALLIC	00000	ORDER BY DESCRIPTION
P1	01801-27601	1	P:MALE 24 PIN	28480	01801-27601
P2	01801-26506	1	P: SLIDE 2 PIN (VERTICAL OUTPUT)	28480	01801-26506
R1	2100-2146	2	R:VAR COMP 10K OHM 10% LIN 3/4W	28480	2100-2146
R2	2100-2146		R:VAR COMP 10K OHM 10% LIN 3/4W	28480	2100-2146
R3	2100-2918	2	R: VAR COMP 2K OHM 10% LIN 1/2W (INCLUDES S1)	28480	2100-2918
R4	2100-1520	2	R:VAR COMP 250 OHM 10% LIN 1/2W	28480	2100-1520
R5	2100-2918		R: VAR COMP 2K OHM 10% LIN 1/2W (INCLUDES S2)	28480	2100-2918
R6	2100-1520		R:VAR COMP 250 OHM 10% LIN 1/2W	28480	2100-1520
S1			N.S.R. PART OF R3		
S2			N.S.R. PART OF R5		
U1	5060-0490	1	IC:INPUT	28480	5060-0490
W3	01830-61601	1	CABLE ASSY:ALT. TRIGGER COAX	28480	01830-61601
W4	01830-61607	1	CABLE ASSY:MAIN	28480	01830-61607
W5	01830-61608	1	CABLE ASSY:SYNC	28480	01830-61608
W6	01830-61609	1	CABLE ASSY:PREAMPLIFIER	28480	01830-61609
W7	01830-61603	1	CABLE ASSY:COAX "A"	28480	01830-61603
W8	01830-61604	2	CABLE ASSY:COAX "B"	28480	01830-61604
W9	01830-61604		CABLE ASSY: COAX "B"	28480	01830-61604
W10	8200-0021	2	WIRE: PHOSPHOR BRONZE 0.126" DIA (2 REQD)	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U.S.A Common.....Any supplier of U.S.		05347	Ultronix, Inc.	San Mateo, Cal.	11236	CTS of Berne, Inc.	Berne, Ind.
00136	McCoy Electronics...Mount Holly Springs, Pa.		05397	Union Carbide Corp., Elect.		11237	Chicago Telephone of	
00213	Sage Electronics Corp..... Rochester, N.Y.			Div.	New York, N.Y.		California, Inc.	So. Pasadena, Cal.
00287	Cemco, Inc.	Danielson, Conn.	05574	Viking Ind. Inc.	Canoga Park, Cal.	11242	Bay State Electronics Corp.	Waltham, Mass.
00334	Humidial	Colton, Calif.	05593	Core Electro-Plastics Inc.	Sunnyvale, Cal.	11312	Teledyne Inc., Microwave	
00348	Micron, Co., Inc.	Valley Stream, N.Y.	05616	Cosmo Plastic (c/o Electrical			Div.	Palo Alto, Cal.
00373	Garlock Inc.	Cherry Hill, N.J.		Spec. Co.)	Cleveland, Ohio	11314	National Seal	Downey, Cal.
00656	Aerovox Corp.	New Bedford, Mass.	05624	Barber Colman Co.	Rockford, Ill.	11453	Precision Connector Corp.	Jamaica, N.Y.
00779	Amp. Inc.	Harrisburg, Pa.	05728	Tiffen Optical Co.		11534	Duncan Electronics Inc.	Costa Mesa, Cal.
00781	Aircraft Radio Corp.	Boonton, N.J.			Roslyn Heights, Long Island, N.Y.	11711	General Instrument Corp.,	
00809	Croven, Ltd.	Whitby, Ontario, Canada	05729	Metro-Tel Corp.	Westbury, N.Y.		Semiconductor Division Products	
00815	Northern Engineering		05783	Stewart Engineering Co.	Santa Cruz, Cal.		Group	Newark, N.J.
	Laboratories, Inc.	Burlington, Wis.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11717	Imperial Electronic, Inc.	Buena Park, Cal.
00853	Sangamo Electric Co.,		06004	Bassick Co., Div. of Stewart		11870	Melabs, Inc.	Palo Alto, Cal.
	Pickens Div.	Pickens, S.C.		Warner Corp.	Bridgeport, Conn.	12136	Philadelphia Handle Co.	Camden, N.J.
00866	Goe Engineering Co.	City of Industry, Cal.	06090	Raychem Corp.	Redwood City, Cal.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.	06175	Bausch and Lomb Optical		12574	Gulton Ind. Inc., Data System	
00929	Microlab Inc.	Livingston, N.J.		Co.	Rochester, N.Y.		Div.	Albuquerque, N.M.
01002	General Electric Co.,		06402	E. T. A. Products Co. of		12697	Clarostat Mfg. Co.	Dover, N.H.
	Capacitor Dept.	Hudson Falls, N.Y.		America	Chicago, Ill.	12728	Elmar Filter Corp.	W. Haven, Conn.
01009	Alden Products Co.	Brockton, Mass.	06540	Amatom Electronic Hardware		12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01121	Allen Bradley Co.	Milwaukee, Wis.		Co., Inc.	New Rochelle, N.Y.	12881	Metex Electronics Corp.	Clark, N.J.
01255	Litton Industries, Inc.	Beverly Hills, Cal.	06555	Beede Electrical Instrument		12930	Delta Semiconductor Inc.	Newport Beach, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.		Co., Inc.	Penacook, N.H.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01295	Texas Instruments, Inc.,		06666	General Devices Co., Inc.	Indianapolis, Ind.	13019	Airco Supply Co., Inc.	Wichita, Kansas
	Transistor Products Div.	Dallas, Texas	06751	Components Inc., Ariz. Div.	Phoenix, Arizona	13061	Wilco Products	Detroit, Mich.
01349	The Alliance Mfg. Co.	Alliance, Ohio	06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.	13103	Thermolloy	Dallas, Texas
01538	Small Parts Inc.	Los Angeles, Cal.	06980	Varian Assoc. Etmac Div.	San Carlos, Cal.	13327	Solitron Devices Inc.	Tappan, N.Y.
01589	Pacific Relays, Inc.	Van Nuys, Cal.	07088	Kelvin Electric Co.	Van Nuys, Cal.	13396	Telefunken (GmbH)	Hanover, Germany
01670	Gudebrod Bros. Silk Co.	New York, N.Y.	07126	Digitran Co.	Pasadena, Cal.	13835	Midland-Wright Div. of	
01930	Amerock Corp.	Rockford, Ill.	07137	Transistor Electronics			Pacific Industries, Inc.	Kansas City, Kansas
01960	Pulse Engineering Co.	Santa Clara, Cal.		Corp.	Minneapolis, Minn.	14099	Sem-Tech	Newbury Park, Cal.
02114	Ferroxcube Corp. of		07138	Westinghouse Electric		14193	Calif. Resistor Corp.	Santa Monica, Cal.
	America	Saugerties, N.Y.		Corp., Electronic Tube Div.	Elmira, N.Y.	14298	American Components, Inc.	Conshohocken, Pa.
02116	Wheelock Signals, Inc.	Long Branch, N.J.	07149	Filmohm Corp.	New York, N.Y.	14433	ITT Semiconductor, a Div. of	
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.	07233	Cinch-Graphik Co.	City of Industry, Cal.		Int. Telephone and Telegraph	
02660	Amphenol-Borg Electronics		07256	Silicon Transistor Corp.	Carle Place, N.Y.		Corporation	West Palm Beach, Fla.
	Corp.	Broadview, Ill.	07261	Avnet Corp.	Culver City, Cal.	14493	Hewlett-Packard Company	Loveland, Colo.
02735	Radio Corp. of America, Semi-		07263	Fairchild Camera & Inst. Corp.,		14655	Cornell Dublier Electric Corp.	Newark, N.J.
	conductor and Materials			Semiconductor Div.	Mountain View, Cal.	14674	Corning Glass Works	Corning, N.Y.
	Division	Somerville, N.J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14752	Electro Cube Inc.	San Gabriel, Cal.
02771	Vocaline Co. of America,		07387	Birtcher Corp, The	Monterey Park, Cal.	14960	Williams Mfg. Co.	San Jose, Cal.
	Inc.	Old Saybrook, Conn.	07397	Sylvania Elect. Prod. Inc.,		15106	The Sphere Co., Inc.	Little Falls, N.J.
02777	Hopkins Engineering Co.	San Fernando, Cal.		Mt. View Operations	Mountain View, Cal.	15203	Webster Electronics Co.	New York, N.Y.
02875	Hudson Tool & Die	Newark, N.J.	07700	Technical Wire Products		15287	Scionics Corp.	Northridge, Cal.
03296	Nylon Molding Corp.	Springfield, N.J.		Inc.	Cranford, N.J.	15291	Adjustable Bushing Co.	N. Hollywood, Cal.
03508	G.E. Semiconductor Prod.		07829	Bodine Elect. Co.	Chicago, Ill.	15558	Micron Electronics	Garden City, Long Island, N.Y.
	Dept.	Syracuse, N.Y.	07910	Continental Device Corp.	Hawthorne, Cal.	15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio	07933	Raytheon Mfg. Co., Semi-		15631	Cabletronics	Costa Mesa, Cal.
03797	Eldema Corp.	Compton, Calif.		conductor Div.	Mountain View, Cal.	15772	Twentieth Century Coil	
03818	Parker Seal Co.	Los Angeles, Cal.	07980	Hewlett-Packard Co.,			Spring Co.	Santa Clara, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.		New Jersey Division	Rockaway, N.J.	15801	Fenwal Elect. Inc.	Framingham, Mass.
03888	Pyrofilm Resistor Co.,		08145	U.S. Engineering Co.	Los Angeles, Cal.	15818	Amelco Inc.	Mountain View, Cal.
	Inc.	Cedar Knolls, N.J.	08289	Blinn, Delbert Co.	Pomona, Cal.	16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
03954	Singer Co., Diehl Div.,		08358	Burgess Battery Co.		16179	Omni-Spectra Inc.	Detroit, Ill.
	Finderne Plant	Sumerville, N.J.			Niagara Falls, Ontario, Canada	16352	Computer Diode Corp.	Lodi, N.J.
04009	Arrow, Hart and Hegeman		08524	Deutsch Fastener Corp.	Los Angeles, Cal.	16554	Electroid Co.	Union, N.J.
	Elect. Co.	Hartford, Conn.	08664	Bristol Co., The	Waterbury, Conn.	16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
04013	Taruus Corp.	Lambertville, N.J.	08717	Sloan Company	Sun Valley, Cal.	16688	Ideal Prec. Meter Co., Inc.,	
04062	Arco Electronic Inc.	Great Neck, N.Y.	08718	ITT Cannon Electric Inc.,			De Jur Meter Div.	Brooklyn, N.Y.
04217	Essex Wire	Los Angeles, Cal.		Phoenix Div.	Phoenix, Arizona	16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.	08727	National Radio Lab. Inc.	Paramus, N.J.	17109	Thermonetics Inc.	Canoga Park, Cal.
04354	Precision Paper Tube Co.	Wheeling, Ill.	08792	CBS Electronics Semiconductor		17474	Tranex Company	Mountain View, Cal.
04404	Palo Alto Division of Hewlett-			Operations, Div. of CBS Inc.	Lowell, Mass.	17675	Hamlin Metal Products Corp.	Akron, Ohio
	Packard Co.	Palo Alto, Cal.	08806	General Electric Co.,		17745	Angstrom Prec. Inc.	No. Hollywood, Cal.
04651	Sylvania Electric Products,			Miniature Lamp Dept.	Cleveland, Ohio	17856	Siliconix Inc.	Sunnyvale, Cal.
	Microwave Device Div.	Mountain View, Cal.	08984	Mel-Rain	Indianapolis, Ind.	17870	McGraw-Edison Co.	Manchester, N.H.
04673	Dakota Engr. Inc.	Culver City, Cal.	09026	Babcock Relays Div.	Costa Mesa, Cal.	18042	Power Design Pacific Inc.	Palo Alto, Cal.
04713	Motorola Inc. Semiconductor		09097	Electronic Enclosures Inc.	Los Angeles, Calif.	18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
	Prod. Div.	Phoenix, Arizona	09134	Texas Capacitor Co.	Houston, Texas	18324	Signetics Corp.	Sunnyvale, Cal.
04732	Filtron Co., Inc. Western		09145	Tech. Ind. Inc. Atchm		18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
	Div.	Culver City, Cal.		Elect.	Burbank, Cal.	18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
04773	Automatic Electric Co.	Northlake, Ill.	09250	Electro Assemblies, Inc.	Chicago, Ill.	18565	Chomerics	Plainville, Mass.
04796	Sequoia Wire Co.	Redwood City, Cal.	09353	C & K Components Inc.	Newton, Mass.	18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
04811	Precision Coil Spring Co.	El Monte, Cal.	09569	Mallory Battery Co. of		18612	Vishay Instruments Inc.	Malvern, Pa.
04870	P.M. Motor Company	Westchester, Ill.		Canada, Ltd.	Toronto, Ontario, Canada	18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
04919	Component Mfg. Service		09795	Pennsylvania Florocarbon	Clifton Heights, Penn.	18911	Durant Mfg. Co.	Milwaukee, Wis.
	Co.	W. Bridgewater, Mass.	09922	Burndy Corp.	Norwalk, Conn.	19315	The Bendix Corp., Navigation &	
05006	Twentieth Century Plastics,		10214	General Transistor Western			Control Div.	Teterboro, N.J.
	Inc.	Los Angeles, Cal.		Corp.	Los Angeles, Cal.	19500	Thomas A. Edison Industries,	
05277	Westinghouse Electric Corp.		10411	Ti-Tal, Inc.	Berkeley, Cal.		Div. of McGraw-Edison	West Orange, N.J.
	Semiconductor Dept.	Youngwood, Pa.	10646	Carborundum Co.	Niagara Falls, N.Y.	19589	Concoa	Baldwin Park, Cal.

00015-49
Revised: May, 1970

From: Handbook Supplements
H4-1 Dated January 1970

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N. Y.	71482	C. P. Clare & Co.	Chicago, Ill.	78452	Thompson-Bremer & Co.	Chicago, Ill.
19701	Electra Mfg. Co.	Independence, Kansas	71590	Centralab Div. of		78471	Tilley Mfg. Co.	San Francisco, Cal.
20183	General Atronics Corp.	Philadelphia, Pa.		Globe Union Inc.	Milwaukee, Wis.	78488	Stackpole Carbon Co.	St. Marys, Pa.
21226	Executone, Inc.	Long Island City, N. Y.	71616	Commercial Plastics Co.	Chicago, Ill.	78493	Standard Thomson Corp.	Waltham, Mass.
21355	Fafnir Bearing Co., The	New Britain, Conn.	71700	Cornish Wire Co., The	New York, N. Y.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71707	Coto Coil Co., Inc.	Providence, R. I.	78790	Transformer Engineers	San Gabriel, Cal.
23020	General Reed Co.	Metuchen, N. J.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78947	Ucinite Co.	Newtonville, Mass.
23042	Texscan Corp.	Indianapolis, Ind.	71785	Cinch Mfg. Co.,		79136	Waldes Kohinoor Inc.	Long Island City, N. Y.
23783	British Radio Electronics Ltd.	Washington, D.C.		Howard B. Jones Div.	Chicago, Ill.	79142	Veeder Root, Inc.	Hartford, Conn.
24455	G. E. Lamp Division, Nela Park	Cleveland, Ohio	71984	Dow Corning Corp.	Midland, Mich.	79251	Wenco Mfg. Co.	Chicago, Ill.
24655	General Radio Co.	West Concord, Mass.	72136	Electro Motive Mfg. Co., Inc.		79727	Continental-Wirt Electronics Corp.	
24681	Memcor Inc., Comp. Div.	Huntington, Ind.			Willimantic, Conn.			Philadelphia, Pa.
26365	Gries Reprodur Corp.	New Rochelle, N. Y.	72619	Dialight Corp.	Brooklyn, N. Y.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N. J.	72656	Indiana General Corp.,		80031	Mepco Division of Sessions Clock Co.	
26851	Compac/Hollister Co.	Hollister, Cal.		Electronics Div.	Keasby, N. J.			Morristown, N. J.
26992	Hamilton Watch Co.	Lancaster, Pa.	72699	General Instrument Corp.,		80033	Prestole Corp.	Toledo, Ohio
28480	Hewlett-Packard Co.	Palo Alto, Cal.		Cap Division	Newark, N. J.	80120	Schnitzer Alloy Products Co.	Elizabeth, N. J.
28520	Heyman Mfg. Co.	Kenilworth, N. J.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	80131	Electronic Industries Association.	
30817	Instrument Specialties Co.,		72825	Hugh H. Eby Inc.	Philadelphia, Pa.		Standard tube or semi-conductor device,	
	Inc.	Little Falls, N. J.	72928	Gudeman Co.	Chicago, Ill.		any manufacturer.	
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	72962	Elastic Stop Nut Corp.	Union, N. J.	80207	Unimax Switch, Div. Maxon Electronics	
35434	Lectrohm Inc.	Chicago, Ill.	72964	Robert M. Hadley Co.	Los Angeles, Cal.		Corp.	Wallingford, Conn.
36196	Stanwyck Coil Products		72982	Erie Technological Products, Inc.	Erie, Pa.	80223	United Transformer Corp.	New York, N. Y.
	Ltd.	Hawkesbury, Ontario, Canada	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	80248	Oxford Electric Corp.	Chicago, Ill.
36287	Cunningham, W. H. & Hill,		73076	H. M. Harper Co.	Chicago, Ill.	80294	Bourns Inc.	Riverside, Cal.
	Ltd.	Toronto, Ontario, Canada	73138	Helipot Div. of Beckman Inst., Inc.		80411	Arco Div. of Robertshaw Controls Co.	
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.			Fullerton, Cal.			Columbus, Ohio
39543	Mechanical Industries Prod. Co.	Akron, Ohio	73293	Hughes Products Division of		80486	All Star Products Inc.	Defiance, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N. H.		Hughes Aircraft Co.	Newport Beach, Cal.	80509	Avery Label Co.	Monrovia, Cal.
40931	Honeywell Inc.	Minneapolis, Minn.	73445	Amperex Elect. Co.	Hicksville, L. I., N. Y.	80583	Hammarlund Co., Inc.	Mars Hill, N. C.
42190	Muter Co.	Chicago, Ill.	73506	Bradley Semiconductor Corp.		80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
43990	C. A. Norgren Co.	Englewood, Colo.			New Haven, Conn.	80813	Dimco Gray Co.	Dayton, Ohio
44655	Ohmite Mfg. Co.	Skokie, Ill.	73559	Carling Electric, Inc.	Hartford, Conn.	81030	International Inst. Inc.	Orange, Conn.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.	73586	Circle F Mfg. Co.	Trenton, N. J.	81073	Grayhill Co.	LaGrange, Ill.
47904	Polaroid Corp.	Cambridge, Mass.	73682	George K. Garrett Co.,		81095	Triad Transformer Corp.	Venice, Cal.
48620	Precision Thermometer &			Div. MSL Industries, Inc.	Philadelphia, Pa.	81312	Winchester Elec. Div. Litton Ind., Inc.	
	Inst. Co.	Southampton, Pa.	73734	Federal Screw Products, Inc.	Chicago, Ill.			Oakville, Conn.
49956	Microwave & Power Tube Div.	Waltham, Mass.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio	81349	Military Specification	
52090	Rowan Controller Co.	Westminster, Md.	73793	General Industries Co., The	Elyria, Ohio	81483	International Rectifier Corp.	El Segundo, Cal.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.	81541	Airpax Electronics, Inc.	Cambridge, Maryland
54294	Shallcross Mfg. Co.	Selma, N. C.	73899	JFD Electronics Corp.	Brooklyn, N. Y.	81860	Barry Controls, Div. Barry Wright Corp.	
55026	Simpson Electric Co.	Chicago, Ill.	73905	Jennings Radio Mfg. Corp.	San Jose, Cal.			Watertown, Mass.
55933	Sonotone Corp.	Elmsford, N. Y.	73957	Groove-Pin Corp.	Ridgefield, N. J.	82042	Carter Precision Electric Co.	Skokie, Ill.
55938	Raytheon Co. Commercial Apparatus		74276	Signalite Inc.	Neptune, N. J.	82047	Sperti Faraday Inc., Copper Hewitt	
	& System Div.	So. Norwalk, Conn.	74455	J. H. Winns, and Sons	Winchester, Mass.		Electric Div.	Hoboken, N. J.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N. Y.	74861	Industrial Condenser Corp.	Chicago, Ill.	82116	Electric Regulator Corp.	Norwalk, Conn.
56289	Sprague Electric Co.	North Adams, Mass.	74868	R. F. Products Division of		82142	Jeffers Electronics Division of	
58474	Superior Elect. Co.	Bristol, Conn.		Amphenol-Borg Electronic Corp.			Speer Carbon Co.	Du Bois, Pa.
59446	Telex Corp.	Tulsa, Okla.			Danbury, Conn.	82170	Fairchild Camera & Inst. Corp.,	
59730	Thomas & Betts Co.	Elizabeth, N. J.	74970	E. F. Johnson Co.	Waseca, Minn.		Space & Defense Systems Div.	Paramus, N. J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio	75042	International Resistance Co.	Philadelphia, Pa.	82209	Magurie Industries, Inc.	Greenwich, Conn.
61775	Union Switch and Signal Div. of		75263	Keystone Carbon Co., Inc.	St. Marys, Pa.	82219	Sylvania Electric Prod., Inc.	
	Westinghouse Air Brake Co.	Pittsburgh, Pa.	75378	CTS Knights, Inc.	Sandwich, Ill.		Electronic Tube Division	Emporium, Pa.
62119	Universal Electric Co.	Owosso, Mich.	75382	Kulka Electric Corp.	Mt. Vernon, N. Y.	82376	Astron Corp.	East Newark, Harrison, N. J.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.	82389	Switchcraft, Inc.	Chicago, Ill.
64959	Western Electric Co., Inc.	New York, N. Y.	75915	Littlefuse, Inc.	Des Plaines, Ill.	82647	Metals & Controls Inc.,	
65092	Weston Inst. Inc. Weston-Newark	Newark, N. J.	76005	Lord Mfg. Co.	Erie, Pa.		Spencer Products	Attleboro, Mass.
66295	Witte Mfg. Co.	Chicago, Ill.	76210	C. W. Marwedel	San Francisco, Cal.	82768	Phillips-Advance Control Co.	Joliet, Ill.
66346	Minnesota Mining & Mfg. Co.		76433	General Instrument Corp.,		82866	Research Products Corp.	Madison, Wis.
	Revere Mincom Div.	St. Paul, Minn.		Micamold Division	Newark, N. J.	82877	Rolton Mfg. Co., Inc.	Woodstock, N. Y.
70276	Allen Mfg. Co.	Hartford, Conn.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.	82893	Vector Electronic Co.	Glendale, Cal.
70309	Allied Control	New York, N. Y.	76493	J. W. Miller Co.	Los Angeles, Cal.	83058	Carr Fastener Co.	Cambridge, Mass.
70318	Allmetal Screw Product Co., Inc.		76530	Cinch-Monadnock, Div. of United Carr		83086	New Hampshire Ball	
		Garden City, N. Y.		Fastener Corp.	San Leandro, Cal.		Bearing, Inc.	Peterborough, N. H.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.	76545	Mueller Electric Co.	Cleveland, Ohio	83125	General Instrument Corp.,	
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	76703	National Union	Newark, N. J.		Capacitor Div.	Darlington, S. C.
70563	Amperite Co., Inc.	Union City, N. J.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.	83148	ITT Wire and Cable Div.	Los Angeles, Cal.
70674	ADC Products Inc.	Minneapolis, Minn.	77068	The Bendix Corp.,		83186	Victory Eng. Corp.	Springfield, N. J.
70903	Belden Mfg. Co.	Chicago, Ill.		Electrodynamics Div.	N. Hollywood, Cal.	83298	Bendix Corp., Red Bank Div.	Red Bank, N. J.
70998	Bird Electric Corp.	Cleveland, Ohio	77075	Pacific Metals Co.	San Francisco, Cal.	83315	Hobbell Corp.	Mundelein, Ill.
71002	Birnbach Radio Co.	New York, N. Y.	77221	Phaostran Instrument and		83324	Rosan Inc.	Newport Beach, Cal.
71034	Bliley Electric Co., Inc.	Erie, Pa.		Electronic Co.	So. Pasadena, Cal.	83330	Smith, Herman H., Inc.	Brooklyn, N. Y.
71041	Boston Gear Works Div. of		77252	Philadelphia Steel and		83332	Tech Labs	Palisades Park, N. J.
	Murray Co. of Texas	Quincey, Mass.		Wire Corp.	Philadelphia, Pa.	83385	Central Screw Co.	Chicago, Ill.
71218	Bud Radio, Inc.	Willoughby, Ohio	77342	American Machine & Foundry Co.		83501	Gavitt Wire and Cable Co., Div. of	
71279	Cambridge Thermionics Corp.	Cambridge, Mass.		Potter & Brumfield Div.	Princeton, Ind.		Amerace Corp.	Brookfield, Mass.
71286	Camloc Fastener Corp.	Paramus, N. J.	77630	TRW Electronic Components Div.	Camden, N. J.	83594	Burroughs Corp., Electronic	
71313	Cardwell Condenser Corp.		77638	General Instrument Corp.,			Tube Div.	Plainfield, N. J.
		Lindenhurst, L. I., N. Y.		Rectifier Division	Brooklyn, N. Y.	83740	Union Carbide Corp., Consumer	
71400	Bussmann Mfg. Div. of		77764	Resistance Products Co.	Harrisburg, Pa.		Prod. Div.	New York, N. Y.
	McGraw-Edison Co.	St. Louis, Mo.	77969	Rubbercraft Corp. of Calif.	Torrance, Cal.	83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
71436	Chicago Condenser Corp.	Chicago, Ill.	78189	Shakeproof Division of		83821	Lloyd Scruggs Co.	Festus, Mo.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.		Illinois Tool Works	Elgin, Ill.	83942	Aeronautical Inst. & Radio Co.	Lodi, N. Y.
71450	CTS Corp.	Elkhart, Ind.	78277	Sigma	So. Braintree, Mass.	84171	Arco Electronics Inc.	Great Neck, N. Y.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.	78283	Signal Indicator Corp.	New York, N. Y.	84396	A. J. Glesener Co., Inc.	San Francisco, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.	78290	Struthers-Dunn Inc.	Pitman, N. J.	84411	TRW Capacitor Div.	Ogallala, Neb.

00015-49

Revised: May, 1970

From: Handbook Supplements
H4-1 Dated January 1970

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.	91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.	96095	Hi-Q Div. of Aerovox Corp.	Olean, N. Y.
85454	Boonton Molding Company	Boonton, N. J.				96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
85471	A. B. Boyd Co.	San Francisco, Cal.	91961	Nahm-Bros. Spring Co.	Oakland, Cal.	96296	Solar Mfg. Co.	Los Angeles, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.	92180	Tru-Connector Corp.	Peabody, Mass.	96396	Microswitch, Div. of	
85660	Koiled Kords, Inc.	Hamden, Conn.	92367	Elgeet Optical Co., Inc.	Rochester, N. Y.		Minn.-Honeywell	Freeport, Ill.
85911	Seamless Rubber Co.	Chicago, Ill.	92607	Tensolite Insulated Wire Co., Inc.		96330	Carlton Screw Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.				96341	Microwave Associates, Inc.	Burlington, Mass.
86197	Clifton Precision Products Co., Inc.		92702	IMC Magnetics Corp.	Westbury, L. I., N. Y.	96501	Excel Transformer Co.	Oakland, Cal.
		Clifton Heights, Pa.	92966	Hudson Lamp Co.	Kearney, N. J.	96508	Xcelite, Inc.	Orchard Park, N. Y.
86579	Precision Rubber Products Corp.	Dayton, Ohio	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N. J.	93369	Robbins & Myers Inc.	Pallisades Park, N. J.	96881	Thomson Ind. Inc.	Long Island, N. Y.
86928	Seastrom Mfg. Co.	Glendale, Cal.	93410	Wire Corp.	Mansfield, Ohio	97464	Industrial Retaining Ring Co.	Irvington, N. J.
87034	Marco Industries	Anaheim, Cal.				97539	Automatic & Precision Mfg.	Englewood, N. J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.	93632	Waters Mfg. Co.	Culver City, Cal.	97979	Reon Resistor Corp.	Yonkers, N. Y.
			93929	G. V. Controls	Livingston, N. J.	97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N. Y.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.	94137	General Cable Corp.	Bayonne, N. J.	98141	R-Tronics, Inc.	Jamaica, N. Y.
			94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.	98159	Rubber Teck, Inc.	Gardena, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.	94148	Scientific Electronics Products, Inc.	Loveland, Colo.	98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
87930	Tower Mfg. Corp.	Providence, R. I.	94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N. J.	98278	Microdot, Inc.	So. Pasadena, Cal.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.	94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N. J.	98291	Sealectro Corp.	Mamaronech, N. Y.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.	94222	South Chester Corp.	Chester, Pa.	98376	Zero Mfg. Co.	Burbank, Cal.
88698	General Mills, Inc.	Buffalo, N. Y.	94330	Wire Cloth Products, Inc.	Bellwood, Ill.	98410	Etc Inc.	Cleveland, Ohio
89231	Graybar Electric Co.	Oakland, Cal.	94375	Automatic Metal Products Co.	Brooklyn, N. Y.	98731	General Mills Inc., Electronics Div.	
89473	G. E. Distributing Corp.	Schenectady, N. Y.	94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.			Minneapolis, Minn.
89479	Security Co.	Detroit, Mich.	94696	Magnecraft Electric Co.	Chicago, Ill.	98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
89665	United Transformer Co.	Chicago, Ill.	95023	George A. Philbrick Researchers, Inc.	Boston, Mass.			Glen Cove, N. Y.
90030	United Shoe Machinery Corp.	Beverly, Mass.	95146	Alco Elect. Mfg. Co.	Lawrence, Mass.	98821	North Hills Electronics, Inc.	
90179	U. S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N. J.	95236	Allies Products Corp.	Dania, Fla.	98978	International Electronic Research Corp.	Burbank, Cal.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.	95238	Continental Connector Corp.	Woodside, N. Y.			New York, N. Y.
90763	United Carr Fastener Corp.	Chicago, Ill.	95263	Leecraft Mfg. Co., Inc.	Long Island, N. Y.	99109	Columbia Technical Corp.	
90970	Bearing Engineering Co.	San Francisco, Cal.	95265	National Coil Co.	Sheridan, Wyo.	99313	Varian Associates	Palo Alto, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.	95275	Vitramon, Inc.	Bridgeport, Conn.	99378	Atlee Corp.	Winchester, Mass.
			95348	Gordos Corp.	Bloomfield, N. J.	99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.	95354	Methode Mfg. Co.	Rolling Meadows, Ill.	99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.	95566	Arnold Engineering Co.	Marengo, Ill.	99800	Delevan Electronics Corp.	East Aurora, N. Y.
91418	Radio Materials Co.	Chicago, Ill.	95712	Dage Electric Co., Inc.	Franklin, Ind.	99848	Wilco Corporation	Indianapolis, Ind.
91506	Augat Inc.	Attleboro, Mass.	95984	Siemon Mfg. Co.	Wayne, Ill.	99928	Branson Corp.	Whippany, N. J.
91637	Dale Electronics, Inc.	Columbus, Nebr.	95987	Weckesser Co.	Chicago, Ill.	99934	Rembrandt, Inc.	Boston, Mass.
91662	Elco Corp.	Willow Grove, Pa.	96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.	99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
91673	Epiphone Inc.	New York, N. Y.				99957	Technology-Instrument Corp. of California	Newbury Park, Cal.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.						
91827	K F Development Co.	Redwood City, Cal.						
91886	Malco Mfg., Inc.	Chicago, Ill.						

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.	000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado	000QQ	Cooltron	Oakland, Cal.
0000Z	Willow Leather Products Corp.	Newark, N. J.	000MM	Rubber Eng. & Development	Hayward, Cal.	000WW	California Eastern Lab	Burlington, Cal.
000AB	ETA	England	000NN	A "N" D Mfg. Co.	San Jose, Cal.	000YY	S. K. Smith Co.	Los Angeles, Cal.
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.						

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to all standard Model 1830A Dual Channel Vertical Amplifiers with a serial prefix (see Section I for explanation) as listed on the title page of this manual. If the serial prefix of your instrument is not the same as the one on the title page, refer to Table 7-1 for the changes necessary to back date this manual to your particular instrument. If the serial prefix of the instrument is not listed either on the title page or in Table 7-1 refer to an enclosed Manual Changes sheet for updating information. Also, if a Manual Changes sheet is supplied, make all indicated Errata corrections.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
942—	2 and 1
967—	2

CHANGE 1

Table 6-2,

- A5C8: Change to HP Part No. 0150-0115; C: fxd cer 27 pF 10% 500 wVdc.
 A5R2: Change to HP Part No. 0757-0449; R: fxd metflm 20K ohms, 1% 1/8W.
 A5R4, A5R5: Factory selected value. Use HP Part No. 0757-0398, R: fxd metflm 75 ohms, 1% 1/8W or HP Part No. 0757-0397, R: fxd metflm 68.1 ohms 1% 1/8W.
 A5R21, A5R23: Factory selected value: Use HP Part No. 0757-0797, R: fxd metflm 90.9 ohms 1% 1/2W or HP Part No. 0757-0796, R: fxd metflm 82.5 ohms, 1% 1/2W.
 A5R22, A5R33: Change to HP Part No. 0757-0279; R: fxd metflm 3160 ohms 1% 1/8W.
 A5R25: Change to HP Part No. 0757-0413; R: fxd metflm 332 ohms 1% 1/8W.
 A5VR1: Change to HP Part No. 1902-3245: VR: breakdown 21.5V 5% 400 mW.
 Figure 8-15, Output Amplifier, A5, Schematic,
 C8: Change value to 27 pF.
 R2: Change value to 20K ohms.
 R4, R5, R21, R23: Add asterisk (*) to indicate factory selected value.
 R22, R33: Change value to 3160 ohms.
 R25: Change value to 332 ohms.
 VR1: Change value to 21.5V.

CHANGE 2

Table 6-2,

- A2: Change to HP Part No. 01830-66504.
 A2C13: Change to HP Part No. 0160-2243; C: fxd cer 2.7 pF $\pm$.25pF 500 wVdc.
 A2C17, A2C18: Delete.
 A5C19, A5C20: Delete.
 A2R24, A2R25, A5R4, A5R5: Change to HP Part No. 01830-61501; R: resistor assembly (special).
 Add: A2R37; HP Part No. 0757-0401; R: fxd metflm 100 ohms 1% 1/8W.
 A5: Change to HP Part No. 01830-69501; A: board assembly, output amplifier (includes C18, U2-U6).
 A5C8: Change to HP Part No. 0160-2265; C: fxd cer 22 pF 5% 500 wVdc.
 A5R37, A5R38: Change to HP Part No. 0757-0390; R: fxd metflm 36.5 ohms 1% 1/8W.
 A5R57: Change to HP Part No. 0757-0836; R: fxd metflm 7500 ohms 1% 1/2W.
 A5R60-A5R65: Delete.
 Figure 8-11, Preamplifier A2, Schematic,
 C17, C18: Delete.
 Add: R37. Connect between U1 pin 13 and junction of CR2/CR3/CR4.
 Revise schematic as shown in Figure 7-1.
 Figure 8-15, Output Amplifier A5, Schematic,
 C19, C20: Delete
 R37, R38: Change value to 36.5 ohms.
 R57: Change value to 7500 ohms.
 R60-65: Delete.
 Revise schematic as shown in Figure 7-2.

7-3. OPTIONS.

7-4. Options for a Hewlett-Packard instrument are standard modifications installed at the factory. No options are offered for the Model 1830A at this time.

7-5. SPECIAL INSTRUMENTS.

7-6. Special instruments are standard HP instruments modified at the factory according to customer specifications. These instruments are identified by a letter-number combination (such as C05—) preceding the standard model number. A tag located adjacent to the instrument serial number tag is used for identification.

7-7. A separate insert sheet is included in the manual for each special instrument which describes the modification and includes modification information affecting the manual. Revise the manual according to the insert sheet for proper instrument coverage. Modifications, such as special paint, which do not affect the standard manual are not included in the insert sheet.

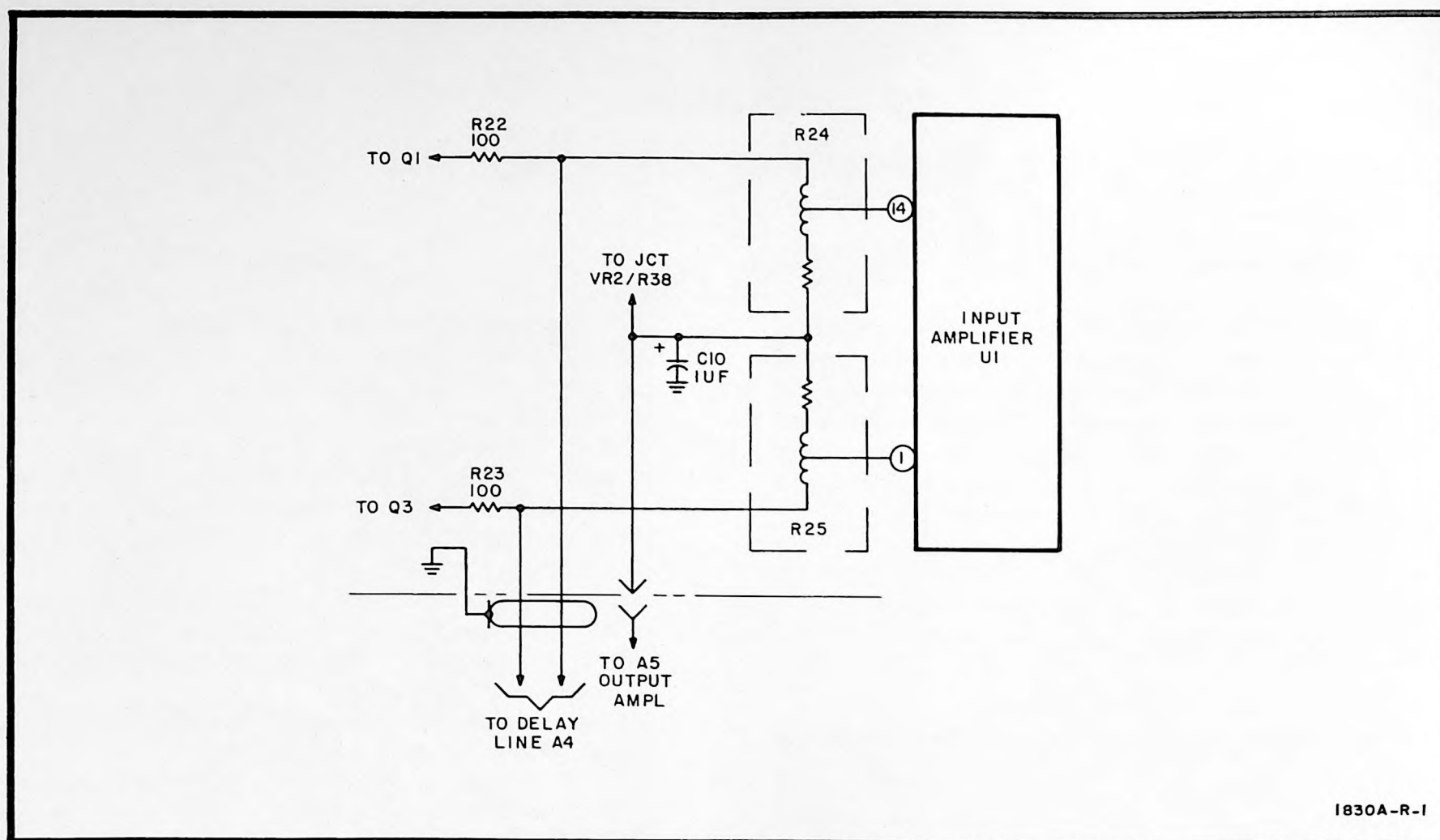


Figure 7-1. Preamplifier Schematic Change

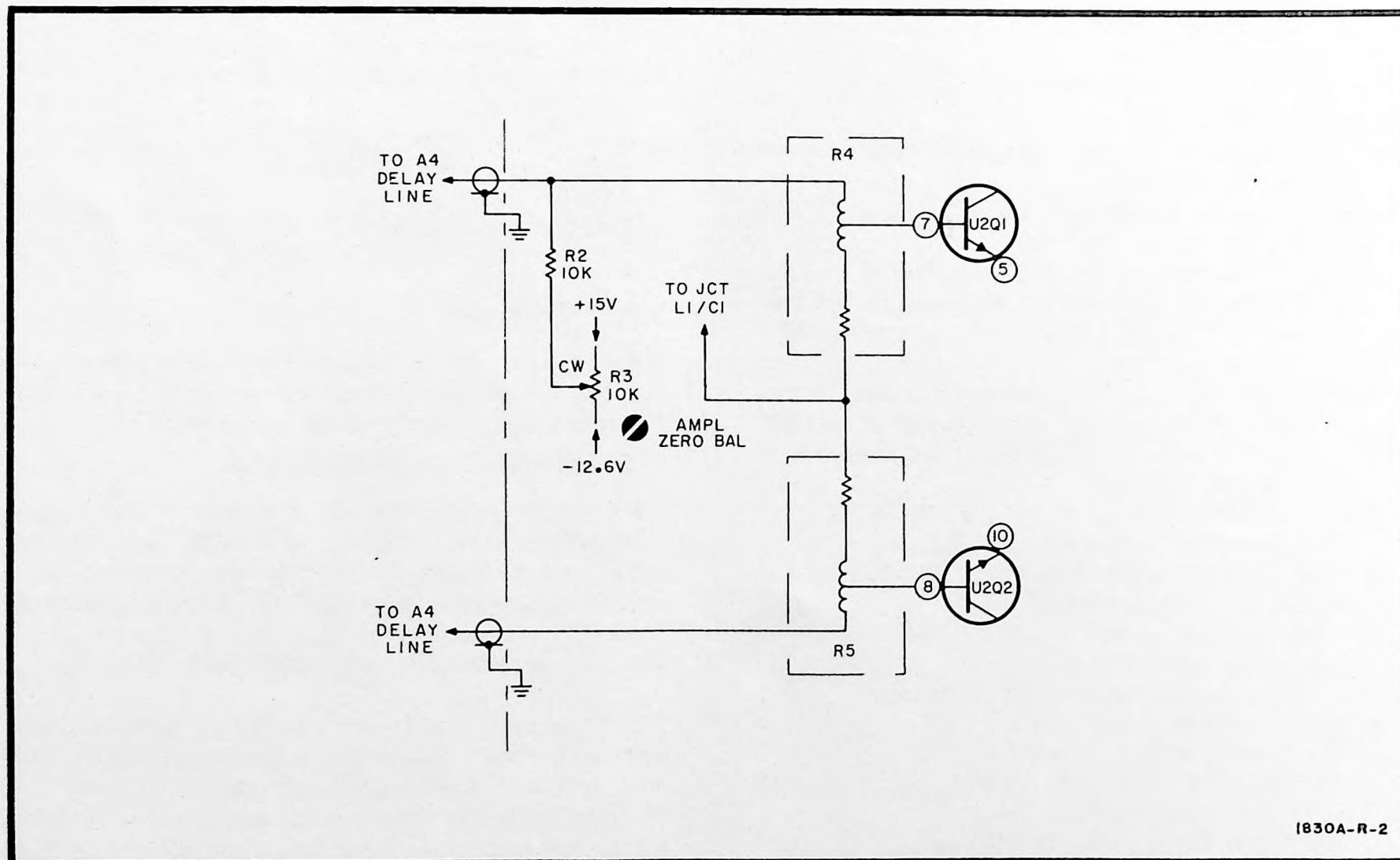


Figure 7-2. Output Amplifier Schematic Change



MANUAL CHANGES

MODEL 1830A

DUAL CHANNEL VERTICAL AMPLIFIER

Manual Serials Prefixed: 968—
Manual Printed: Nov 1970

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
981—	1	1227A	1 thru 5
1104—	1, 2		
1129A	1, 2, 3		
1140A	1, 2, 3, 4		

ERRATA

Page 3-1, Paragraph 3-8,

Add the following sentence to Paragraph 3-8: In down-Vernier conditions, increased perturbations are normally encountered.

Page 5-3, Paragraph 5-17,

Change Paragraph 5-17a to read as follows:

Set DISPLAY to CHOP and Time Base SWEEP TIME/DIV to 10 usec.

Change Paragraph 5-17b to read as follows:

Adjust Time Base trigger level control to verify that stable display of chopped transients cannot be obtained.

Page 5-4, Paragraph 5-21f,

Change last sentence to read: (Disregard any overshoot which may be caused by fast-rise pulse generator and down-Vernier condition.)

Page 5-11, Paragraph 5-36a,

Delete all reference to Model 183A/B Oscilloscope.

Change Paragraph 5-36b to read as follows: Connect Model 213B Pulse Generator to Channel A INPUT using short length of 50-ohm cable.

Table 6-2, Replaceable Parts,

ADD: A1A1MP1 and A1A2MP1: HP Part No. 0380-0971, SPACER: 1.468 IN. LG, Mfr. Code 00000, Mfr. Part No. OBD.

A2C3: Add to Description, FACTORY-SELECTED VALUE — NOMINAL VALUE SHOWN.

A2CR4: Change to HP Part No. 1901-0040, RECTIFIER: FAST RECOVERY 30 AMP 100V, Mfr. Code 04713, Mfr. Part No. M8891.

A2E5: Change to HP Part No. 0360-1514, TERMINATION: PIN SQUARE, Mfr. Code 28480, Mfr. Part No. 0360-1514.

A2L1: Change to HP Part No. 9170-0029, CORE: FERRITE BEAD, Mfr. Code 02114, Mfr. Part No. 58-590-56A2/4A.

Table 6-2, Replaceable Parts (Cont'd),

ADD: A2R63: HP Part No. 0698-7188, R: FXD FLM 10 OHM 2% 1/8W (FACTORY SELECTED VALUE), Mfr. Code 28480, Mfr. Part No. 0698-7188.

A2S1: Change to HP Part No. 3101-0535, SWITCH: PUSH-BUTTON 2P SINGLE STATION, Mfr. Code 71590, Mfr. Part No. PB-1.

ADD: A2XU1, HP Part No. 1200-0441, SOCKET: IC 14-PIN MIN, Mfr. Code 28480, Mfr. Part No. 1200-0441.

A5C3: Change to HP Part No. 0160-3647, C: FXD CER 22 PF 5% 100VDCW, Mfr. Code 72982, Mfr. Part No. 8111-A112-COG-220J.

△ A5C17: Change to HP Part No. 0160-3448, C:FXD CER 1000 PF 10% 1000VDCW, Mfr Code 56289, Mfr Part No. C067B251F102KS25-CD.

A5C18: Change to HP Part No. 0160-3848, C: FXD CER 3.3PF 100VDCW (FACTORY SELECTED VALUE), Mfr. Code 28480, Mfr. Part No. 0160-3848.

ADD: A5C21, HP Part No. 0160-2236, C: FXD CER 1.0PF 500VDCW (FACTORY SELECTED VALUE), Mfr. Code 72982, Mfr. Part No. 301-000-COKO-109C.

A5E5: Change to HP Part No. 0360-1514, TERMINAL: PIN SQUARE, Mfr. Code 28480, Mfr. Part No. 0360-1514.

A5R12 and A5R13: Change to HP Part No. 0757-0795, R: FXD MET FLM 75 OHM 1% 1/2W, Mfr. Code 28480, Mfr. Part No. 0757-0795.

A5R19: Change to HP Part No. 0760-0027, R: FXD METOX 150 OHM 2W, Mfr. Code 28480, Mfr. Part No. 0760-0027.

A5R21 and A5R23: Delete entries for HP Part No. 0757-0796 and 0757-0797.

A5R25: Change to HP Part No. 0757-0411, R: FXD MET FLM 332 OHM 1% 1/8W, Mfr. Code 28480, Mfr. Part No. 0757-0411.

A5R33: Change to HP Part No. 0757-0433, R: FXD MET FLM 3320 OHM 1% 1/8W (FACTORY SELECTED VALUE), Mfr. Code 28480, Mfr. Part No. 0757-0433.

6 November 1974

△ = Latest additions to this change sheet.

This change sheet supersedes all prior change sheets for this manual.

Supplement A for
01830-90902

ERRATA (Cont'd)

Table 6-2, Replaceable Parts (Cont'd)

A5R43 thru A5R46: Change to HP Part No. 5080-9669, R: FACTORY SELECTED VALUE, Mfr. Code 28480, Mfr. Part No. 5080-9669.

A5R55: Change to HP Part No. 0760-0022, R: FXD METOX 330 OHM 2% 1W, Mfr. Code 28480, Mfr. Part No. 0760-0022.

ADD: A5R66, HP Part No. 0698-7209, R: FXD FLM 75 OHM 2% 1/8W, Mfr. Code 28480, Mfr. Part No. 0698-7209.

ADD: A5R67: HP Part No. 0698-7196, R: FXD FLM 21.5 OHM 2% 1/8W, Mfr. Code 28480, Mfr. Part No. 0698-7196.

E6: Change to HP Part No. 0362-0227, TERMINATION: CRIMP LUG FOR 26 AWG WIRE, Mfr. Code 27264, Mfr. Part No. 2125.

MP13: Change to HP Part No. 5040-5996, LEVER: COUPLING, Mfr. Code 28480, Mfr. Part No. 5040-5996.

DELETE: MP16 and MP20.

MP33: Change to HP Part No. 01821-21702, BUSHING: POT 14-32 EXT THREAD (CAL), Mfr. Code 28480, Mfr. Part No. 01821-21702.

R1, R2: Change to HP Part No. 2100-2488, R: VAR COMP 10K OHMS 20% LIN 1/2W, Mfr. Code 28480, Mfr. Part No. 2100-2488.

Figure 8-11, Page 8-11,

A2C3: Add asterisk to symbol.

ADD: A2R63 (10 OHMS) with asterisk. Connect between A2C3 and junction of A2U1, pin 11 and A2R12.

Figure 8-15, Page 8-13/8-14,

ADD: A5C21 (1.0 PF) with asterisk. Connect between pins 1 and 14 of A5U1 (Q3 and Q4).

ADD: A5R66 (75 OHMS) between A5C3 and junction of A5R7, 8, 9, and 10.

ADD: A5R67 (21.5 OHMS) in series between A5C20 and A5U6, pin 10.

A5C3: Change value to 22 PF.

A5C18: Change value to 3.3 PF and add an asterisk to show factory selected value.

A5R12: Change value to 75 ohms.

A5R13: Change value to 75 ohms.

A5R19: Change value to 150 ohms.

A5R21: Change value to 75 ohms and add an asterisk to show factory-selected value.

A5R23: Change value to 75 ohms and add an asterisk to show factory-selected value.

A5R25: Change value to 332 ohms.

A5R33: Change value to 3320 ohms and add an asterisk to show factory-selected value.

A5R43 thru A5R46: Delete the value and show only an asterisk.

A5R55: Change value to 330 ohms.

CHANGE 1

Table 6-2,

Add: A5E6, HP Part No. 01830-69101, TQ2,
Ground strip, finger contact (2 reqd).
MP12: Change to HP Part No. 01830-64701,

Table 6-2, (Cont'd)

TQ1, Bracket, shelf assy, Mfr. Code 28480, Mfr.
Part No. 01830-64701.
W4: Change to HP Part No. 01830-61611.

CHANGE 2

Table 1-1, Page 1-0,

A + B OPERATION: Change to read:
Bandwidth: DC to 150 MHz, 3 dB down from
6-div reference signal, 50-ohm source.
Risettime: ≤ 2.4 ns 10% to 90% with 6-div
input step, 50-ohm source.

Table 6-2,

ADD: A2C19 and A2C20, HP Part No. 0160-
2263, C: FXD CER 18 PF 5% 500 VDCW,
Mfr. Code 72982, Mfr. Part No. 301-000-COG0-
180J.
Add: A2CR9, HP Part No. 1901-0047; DIODE:
SILICON 20 PIV, Mfr. Code 28480, Mfr. Part
No. 1901-0047.

Table 6-2, (Cont'd)

Add: A2E6, HP Part No. 0360-1244; TQ2; INSERT:
TEFLON, Mfr. Code 00000, Mfr. Part No. OBD.
Add: A2R61, HP Part No. 0684-1021; TQ2, R: FXD
COMP 1000 OHMS 10% 1/4W, Mfr. Code 01121,
Mfr. Part No. CB1021.
Add: A2R62, HP Part No. 0684-1021; R: FXD
COMP 1000 OHMS 10% 1/4W, Mfr. Code 01121,
Mfr. Part No. CB 1021.
MP12: Change to HP Part No. 01830-04701;
SUPPORT: PLUG-IN, Mfr. Code 28480, Mfr.
Part No. OBD.
Figure 8-11, Page 8-11,
Change Schematic to conform to Figure 1.

CHANGE 3

Table 6-2,

A2: Change to HP Part No. 01830-66508;
BOARD ASSY: PREAMPLIFIER, Mfr. Code
28480, Mfr. Part No. 01830-66508.

Table 6-2 (Cont'd),

A2C17: Delete.
Figure 8-11, Page 8-11,
A2C17: Delete.

CHANGE 4

Table 6-2,

A3: Change to HP Part No. 01830-66509;
BOARD ASSY: DISPLAY MODE, Mfr.
Code 28480, Mfr. Part No. 01830-66509.

Table 6-2, (Cont'd)

W6: Change to HP Part No. 01830-61612; CABLE
ASSY: PREAMPLIFIER, Mfr. Code 28480, Mfr.
Part No. 01830-61612.

CHANGE 5

Table 6-2,

A1A3: Change to HP Part No. 01830-61905;
SWITCH ASSY: CHANNEL A, Mfr. Code
28480, Mfr. Part No. 01830-61905.

Table 6-2, (Cont'd)

A1A4: Change to HP Part No. 01830-61906;
SWITCH ASSY: CHANNEL B, Mfr. Code
28480, Mfr. Part No. 01830-61906.

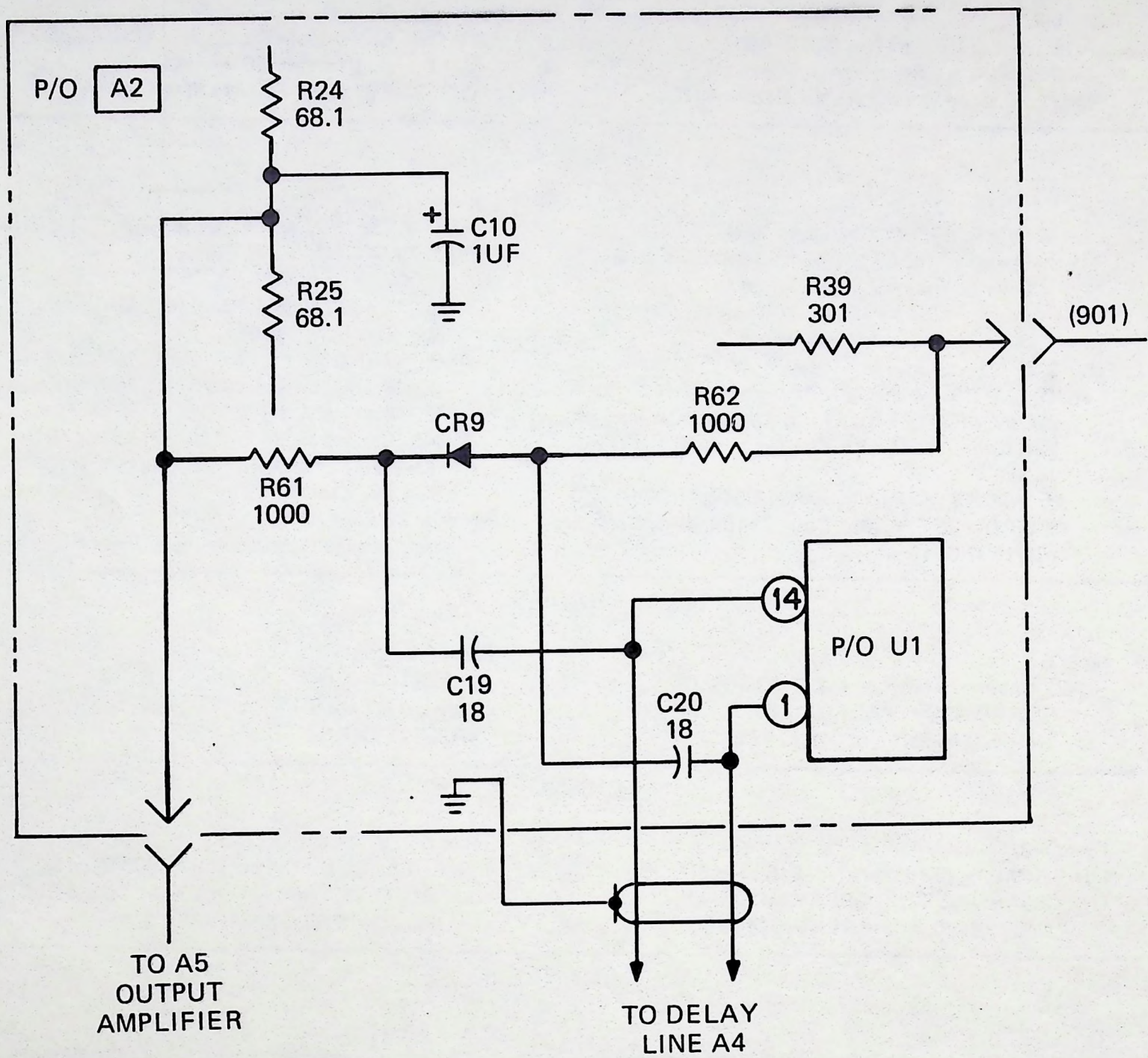


Figure 1. Circuitry Added in Change 2

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematic diagrams, component location pictorials, troubleshooting information and repair and replacement procedures for the Model 1830A.

8-3. SCHEMATIC DIAGRAMS.

8-4. Schematic diagrams appear on right hand pages that unfold outside the right edge of the manual. These "throw clear" pages allow viewing the schematics while referring to text and figures in another section. The text can be followed by unfolding the appropriate "throw clear" page.

8-5. Schematics are drawn primarily to show the electronic function of an instrument, and a given schematic may include all or part of several assemblies. Schematics also include dc voltages and waveform measurement test points. Waveforms applicable to each schematic are shown opposite that schematic, along with DC voltage and waveform measurement conditions. Information explaining the symbols and conventions used in these schematics is provided by Table 8-1.

8-6. COMPONENT IDENTIFICATION.

8-7. Chassis mounted parts, not on an assembly, are identified in Figure 6-1. The identification of assembly

mounted components is shown on the page opposite the schematic of the assembly. All components within the shaded area of a schematic are physically located on an etched circuit board. Components not physically located on an etched circuit assembly are shown in the white area of the schematics and have only basic component designators such as R1 or C1. These parts are listed in the replaceable parts list under Chassis Parts. The plug-in integrated circuit used as the Input Amplifier (U1) is not a component of the Preamplifier Assembly, A2, and must be ordered separately. It is listed under Chassis Parts in Table 6-2, Replaceable Parts. The Output Amplifier Assembly, A5 has five soldered-in integrated circuits. Be sure to order the complete assembly by the part number listed in Table 6-2.

8-8. REFERENCE DESIGNATIONS.

8-9. The unit system of reference designation, used in this manual, is in accordance with the provisions of the American Standard Electrical and Electronics Reference Designations. Minor variations, due to design and manufacturing, may be noted. A brief explanation is presented here for those unfamiliar with the designation system.

8-10. Each component is identified by a letter-number combination. For example R1, R2, ---C1, C2; etc. This letter-number combination is the basic designator for each

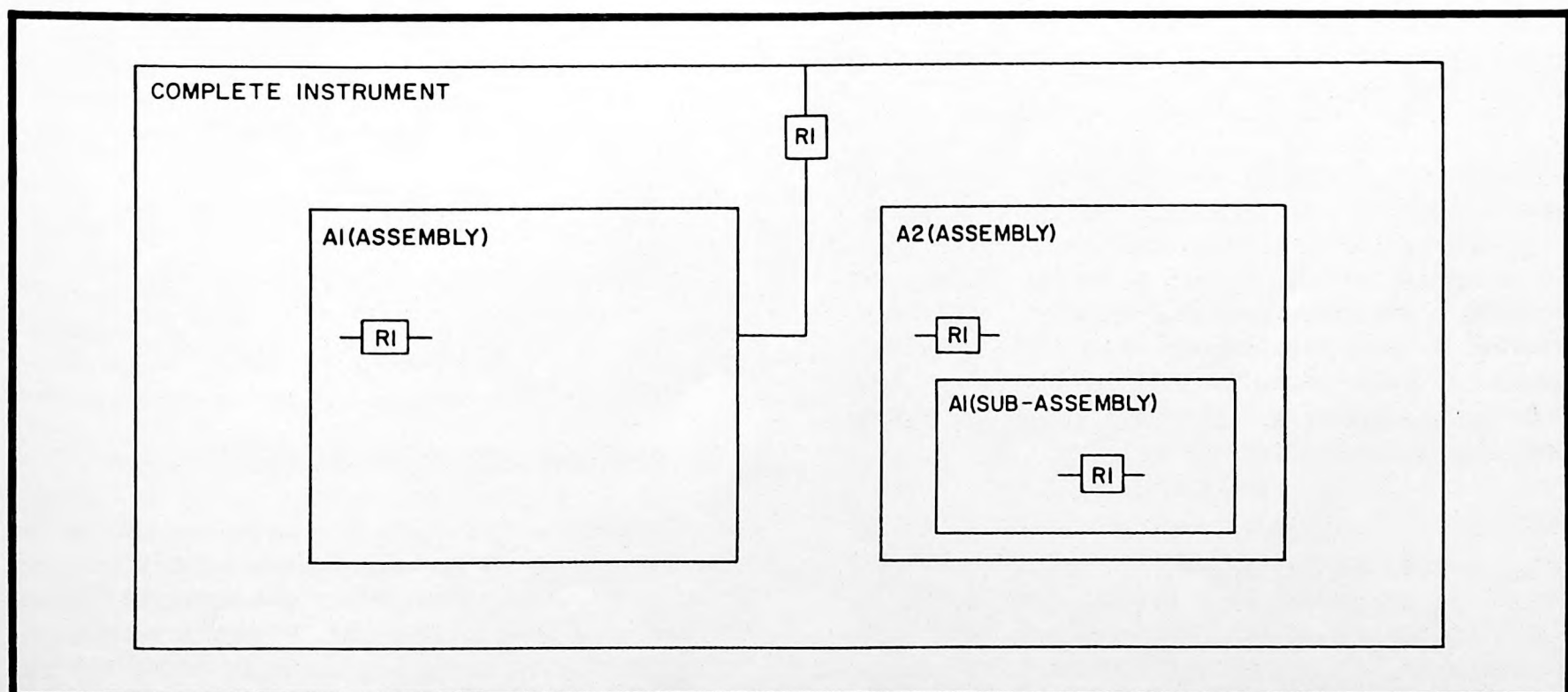


Figure 8-1. Unit System Reference Designation

component. Components which are separately replaceable and are part of an assembly have, in addition to the basic designator, a prefix designator which identifies the assembly on which the component is located. Components not mounted on an assembly have only the basic reference designator.

8-11. Figure 8-1 is used as an example. The basic reference designator (R1) appears four times, however each R1 is identified by a designator formed by combining component, assembly and sub-assembly designators. Consider the R1 on sub-assembly A1. The complete designator of the resistor is A2A1R1. Now, R1 connected between assembly A1 and the complete instrument has only the designator R1 because it is not mounted on an assembly. This system applies to all classes of components, C, CR, Q, etc.

8-12. Assemblies are numbered from 1, consecutively. If an assembly number is assigned and later deleted, this number is not reused. A reference designation chart on each schematic lists all components shown in that schematic, and those component designators not used or which have been superseded are listed as deleted below each chart.

8-13. TROUBLESHOOTING.

8-14. GENERAL.

8-15. The first and most important requirement for successful troubleshooting is a thorough understanding of how the instrument is designed to operate. Section III (Operation) and Section IV (Theory of Operation) of this manual are intended to provide the operator with the necessary understanding to troubleshoot this instrument. Many times suspected malfunctions are caused by improper control settings or system hook-up. Therefore, it is recommended that the operator become as familiar as possible with the operation of the Model 1830A before attempting to troubleshoot it.

8-16. To locate a trouble, start with a thorough visual inspection of front panel control settings and hook-up. Next, look for burned or loose components, mis-wiring or any condition which suggests a trouble. Square pin connections are shown on each component identification pictorial. Refer to these callouts, after a board has been replaced, to assure proper connections. Correct any faults located and check the instrument performance before continuing to troubleshoot.

8-17. The first electrical check should be to ensure proper supply voltages are available to the printed circuit boards. Use the overall block diagram (Section IV), the schematic diagrams, and the waveform photo adjacent to the schematic. This procedure will isolate the trouble to a particular circuit. When trouble appears probable in a circuit, check the dc voltages given on the schematics.

8-18. WAVEFORMS AND DC VOLTAGES.

8-19. Typical waveform measurement points (refer to Table 8-1) are located at strategic points along the main signal path. The numbers inside the symbol refer to a corresponding waveform photo. Conditions for making the waveform measurements are provided with the waveform photos.



This instrument is designed to operate with the Model 183A/B Oscilloscope. Do not attempt to use it with other HP Model 180-series Oscilloscopes. A mechanical interlock is provided on the associated Time Base plug-in which prevents full insertion of the mated units. Do not attempt to perform maintenance or adjustments on the Model 1830A by connecting it to one of the other HP Oscilloscopes with an extender cable, since they do not supply the required operating power.

8-20. DC voltage levels are shown on schematic diagram for all active components (transistors, mainly). Conditions for making dc voltage measurements are given adjacent to the schematics. In locating points on printed circuit boards, note a small dot etched on the board identifying the emitter lead of transistors, the pin 1 lead of IC's, the cathode lead of diodes, and the positive side of electrolytic capacitors.

8-21. The voltages shown on the schematics and the waveform photographs provided are invaluable in troubleshooting the instrument. Use them for checking stage operation and gain, locating faulty transistors and components, etc. Always refer to the specific measurement conditions before using dc voltages or waveforms. Allow sufficient warmup time to permit levels to stabilize before noting dc voltages.



When observing waveforms or making dc voltage measurements, use extreme care to avoid shorting supply voltages or components.

8-22. REPAIR AND REPLACEMENT.

8-23. The following paragraphs provide procedures for replacing components and special considerations for removing components from etched circuit boards. Section VI provides a detailed parts list to permit ordering of replacement parts. If satisfactory repair or replacement cannot be accomplished, contact the nearest HP Sales/Service Office (addresses at rear of this manual) for

assistance. If shipment for repair is recommended, see Section II of this manual for repackaging and shipping information.

8-24. SERVICING ETCHED CIRCUIT BOARDS.

8-25. Etched circuit boards used in the Model 1830A have components mounted on both sides, conductive circuits on both sides, and plated-through component mounting holes. The circuit boards are prepared from an insulating material with metallic conducting surfaces bonded to both sides, and the component mounting holes are plated-through during manufacturing. This extends the metallic connection through to both sides of the circuit board. Components may therefore be removed by heating the joint from either side of the board. Hewlett-Packard Service Note M-20E contains useful information on servicing and repair of printed circuit boards. Some important considerations are as follows:

a. Use a 37 to 47.5 watt chisel tip soldering iron with a tip diameter of 1/16 to 1/8 inch, and a small diameter rosin core solder.

b. Components may be removed by placing the soldering iron to component connections on either side of the board. If heat is applied to the component side of the board, greater care is required so as not to damage adjacent components. Extreme care is required to avoid damage to semiconductor devices. Heat damage may be minimized by using long nose pliers to grip the component lead between soldering iron and component. Possible damage to a component is greatly reduced by the heat sinking effect of the pliers.

c. If a component is obviously damaged or faulty, clip the leads close to the component, then unsolder the leads from the board.

d. Large components, such as potentiometers and pushbutton switches, may be removed by rotating the iron from one lead to another while gently applying pressure to lift the component from the board.

e. Excessive heat or force will destroy the laminate bond between the metal plated surface and the board. If this should occur, the lifted conductor may be cemented down with a small amount of quick-drying acetate-base cement having good insulating properties. If this repair cannot be accomplished, a section of good conducting wire may be soldered along the damaged area.

f. Before replacing a component, heat the remaining solder in the component hole and clean it out with a toothpick or "solder sucker". Sharp pointed metallic tools are not recommended because they may damage the plated through surface of the hole.

g. Tin and shape leads of replacement component to fit existing holes.

h. Install components in the same position as the original component.

i. When removing or replacing square pin connections be sure to pull straight up for removal and replacement. These connections can loosen and cause poor contact.

8-26. INTEGRATED CIRCUIT REPLACEMENT.

8-27. The IC used as the preamplifier (U1) is a plug-in type. All others used in this instrument are soldered in place. The Integrated Circuit (IC) packages are relatively expensive. Unless the unit to be removed has been definitely determined to have failed, great care should be taken to prevent damage when removal or replacement is desired. Soldering irons which can simultaneously heat all soldered connections are available from various manufacturers. This type of iron permits rapid removal of the IC Package in one operation. Also available are soldering irons with a built-in "solder sucker" which facilitates quick removal.

8-28. The following procedure is recommended if a standard soldering iron is used for IC removal:

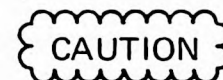
a. Use a soldering iron having a small pencil tip (e.g. Weller No. PT-H7), and carefully heat an IC lead solder joint. When the solder is fluid, quickly remove the solder with a "solder sucker". Repeat until all IC leads have been freed.

b. Check each lead by carefully moving it with a long nose pliers to be sure that it is mechanically free from the circuit board.

c. When all leads are loose, carefully remove the IC package. The dual in-line type package may be removed by gently gripping the top and bottom with long nose pliers and carefully rolling the package out.

d. Using a solder sucker or toothpick carefully remove all remaining solder from the plated through holes.

e. Insert the replacement IC package into the circuit board, and connect it by using the soldering procedures recommended previously.



Be extremely careful not to damage the IC package by heat from the soldering iron. Work quickly and carefully.

8-29. When replacing an integrated circuit package take careful note of the mark or notch which is provided for package orientation. The component identification photos and the integrated circuit pin location diagrams of this manual show the IC orientation.

8-30. DISASSEMBLY INFORMATION.

8-31. If it is necessary to remove a circuit assembly for servicing or replacement, the following information will provide guidance in accomplishing this in a manner to prevent damage and facilitate removal and replacement. The instrument has been designed to readily permit disassembly for component replacement and servicing. All power is first connected into the Output Amplifier board assembly (A5) and from that board to the Preamplifier Assembly (A2) or the front panel. Removing the square pin connectors from the Output Amplifier will disconnect all power from the instrument. The mechanical and electrical design permits quick removal of the front panel alone or of the entire assembly consisting of the front panel, preamplifier, attenuators, input switches and display switch as a unit.

8-32. The Preamplifier and the Output Amplifier printed circuit boards use square pin connectors for power and control wiring connections. High frequency connections are made by means of coax. cables. While the Alternate Trigger input coax. is soldered directly to the Preamplifier board, all other coax. connections to circuit boards have two screws which provide a mechanical and electrical connection, with the coax. center conductor soldered to the circuit board. The Delay Line has two center conductors. When disconnecting the square pins, lift the connector straight off the circuit board. If long nose pliers are used for this purpose, take care not to deform the connector by twisting or using excessive pressure.

8-33. In removing the coax. cables, first remove the holding screws, then heat the soldered joint of the center conductor and apply a gentle pull to the cable to remove it. The Delay Line coax. cable connection requires simultaneous heating of both conductors. Before reconnecting coax. cables, remove any solder from the plated through holes. Then insert the cable, holding it in place with the mounting screws and solder. RF input connections to the circuit boards use printed circuitry ground planes. Do not use an excess of solder in connecting to them and be certain to remove all remaining flux from the soldered area.

8-34. FRONT PANEL REMOVAL. To gain access to those front panel components which cannot be easily reached from the open side of the instrument, or to those mounted on the input switch boards, remove the front panel. First remove the angle strut bracket which is held by two screws at the rear of the instrument and one at the front. Disconnect all the square pin connectors from the preamplifier board and the five preamplifier cable square pin connections to the output board. Release the signal input jacks from the front panel by removing, from the front of the instrument, the BNC locknuts and push the connectors through the panel to the interior of the instrument. Unsolder the single (905) wire from the lower side of the Channel B switch board. Remove both VOLTS/DIV knobs, switch levers, spacers and hex nuts.

The three screws holding the panel to the chassis should now be removed. This will free the front panel with its components, including the Display switch, for servicing.

8-35. SIGNAL CONDITIONING ASSEMBLY REMOVAL. The easiest method of removing the Preamplifier circuit board, the attenuators or input switches is by separating the signal conditioning assembly from the instrument. This will allow the coax. cables connecting the preamplifier, input switches and attenuators to be readily disconnected. To accomplish this, first remove the angle strut bracket from the frame. There are two screws at the rear of the instrument and one at the front. Disconnect the five square pin wire leads of the preamplifier cable harness from the output board.

8-36. The Alternate Trigger coax. should be removed next. This cable is soldered directly to the board. Heat the connections from the component side of the board to prevent burning or melting of the wire insulation. Remove the three screws which hold the front panel to the instrument frame, and the two screws located in line directly underneath the 24 pin mating plug. The assembly is now held to the chassis by the delay line and sync cables. Two screws and two soldered connections hold the delay line in place. Remove the screws and unsolder the delay line by heating both connections from the top of the board. The Sync cable connector is of floating construction. Remove it from the frame by holding the larger inner hex nut firmly while loosening and removing the outside nut. The entire assembly should now be free. If it is desired that the preamplifier board be removed, each of the coax. cables must be disconnected. Two screws, as well as a solder connection, fasten the Channel A cable, two Channel B cables and the Sync output cable to the board. Disconnect them by first removing the screws and then unsoldering the center conductor. Four screws through standoffs hold the preamplifier board to the attenuators, and should be removed for access to the components which are back mounted on the board.

8-37. The resistive divider networks of the attenuator can be reached by removing the attenuator shield. Three screws hold the spring shield in place. Each input switchboard can be separately removed from the assembly. When removing the Channel B switchboard, be sure to unsolder the single wire (905) connected to it. The cables to the attenuator input are soldered as well as screwed to the attenuator. Therefore they should be disconnected from the switch board prior to removal from the attenuator. Two long screws are used to hold the input shield and switchboard to the attenuator bracket. Removing them and the coax. cable(s) will separate the switchboards from the assembly. During reassembly it may be helpful to remove the circuit board. This will make it easier to reconnect the delay line.

8-38. OUTPUT AMPLIFIER REMOVAL. While the output amplifier board is simple to remove, do so with caution and follow the instructions given here to prevent

damage to the integrated circuit packaged assemblies which are located on under side of the board. First remove the angle strut bracket (three screws). Next remove the Delay Line connection to the board by first removing the two screws and then unsoldering the connections. Carefully unsolder the output connector wires from the circuit board. Note that there are three screws located in the approximate center of the board. These ensure that the integrated circuit packages are properly held to the output heat sink. Remove the square pin connectors, pulling them straight away from the board. Now remove the remaining two screws from the corners of the board, followed by removal of the three screws located in the center of the board holding the integrated circuits to the heat sink. The assembly should now be free for removal.

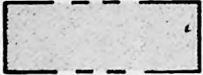
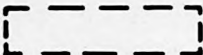
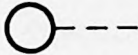
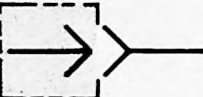
8-39. When reinstalling the Output Amplifier assembly a thin coating of silicone grease should be wiped on the case of each integrated circuit. The use of DOW CORNING 5 Compound or similar is recommended. Do not use a silicone compound which has a filler material, since the only function desired is that of heat transfer. For this purpose an unfilled material permitting close contact is desired. When remounting the board, center it in place by loosely inserting the three center screws first. They should, at this time, be tightened only enough to hold the board in place. Install and tighten the two bottom corner screws, followed by reconnection of the output leads. In soldering these to the circuit board, ensure a smooth and neat joint

so as to not introduce any impedance change which may affect circuit operation. Be sure to clean off any remaining flux from the joints. Install and tighten both top corner screws. Then firmly tighten (5 oz-in) the three center screws. Do not overtighten these, since they directly stress the integrated circuit packages. Reconnect the delay line, holding it in place with the two screws prior to soldering, and remove any excess flux. Replacing the square pin connectors and the angle strut bracket completes the reinstallation of this assembly. DOW CORNING 5 Compound is available in 8 oz. tubes from Hewlett-Packard. Order HP Part No. 8500-0059.

8-40. INPUT SWITCHES. Each of the input switch assemblies, A1A3 and A1A4, use an etched circuit board as a part of the switch. If replacement is required, the entire switch assembly should be replaced as a unit. The switch can be disassembled for cleaning. Removing the retainer ring will release the two rotor sections from the circuit board. The rotor contacts, which are a part of the front rotor section, and the etched circuit board switch area can be cleaned with MS-180 FREON TF DEGREASER or similar. Before reassembly the etched circuit board contact area should be very lightly lubricated. A thin coat of LUBRIPLATE is used when originally manufactured. This is available from Hewlett-Packard; order HP Part No. 6040-0018. The component identification photographs for A1A3 and A1A4 illustrate the correct reinstallation position of the rotors for these switches.

Table 8-1. Schematic Diagram Notes

Refer to MIL-STD-15-1A for schematic symbols not listed in this table.

	= Etched circuit board
	= Front panel marking
	= Rear panel marking
	= Front panel control
	= Screwdriver adjustment
P/O	= Part of
CW	= Clockwise end of variable resistor
N C	= No connection
	= Waveform test point (with number)
	= Common electrical point (with letter) not necessarily ground
	= Single pin connector on board
	= Pin of a plug-in board (with letter or number)
	= Main signal path
	= Primary feedback path
	= Secondary feedback path
*	= Optimum value selected at factory, average value shown; part may have been omitted.



= Field effect transistor (N-channel)



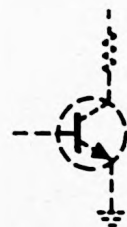
= Breakdown diode



= Tunnel diode



= Step recovery diode



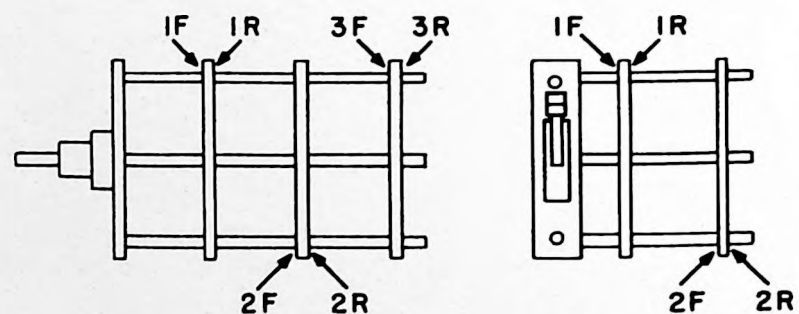
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

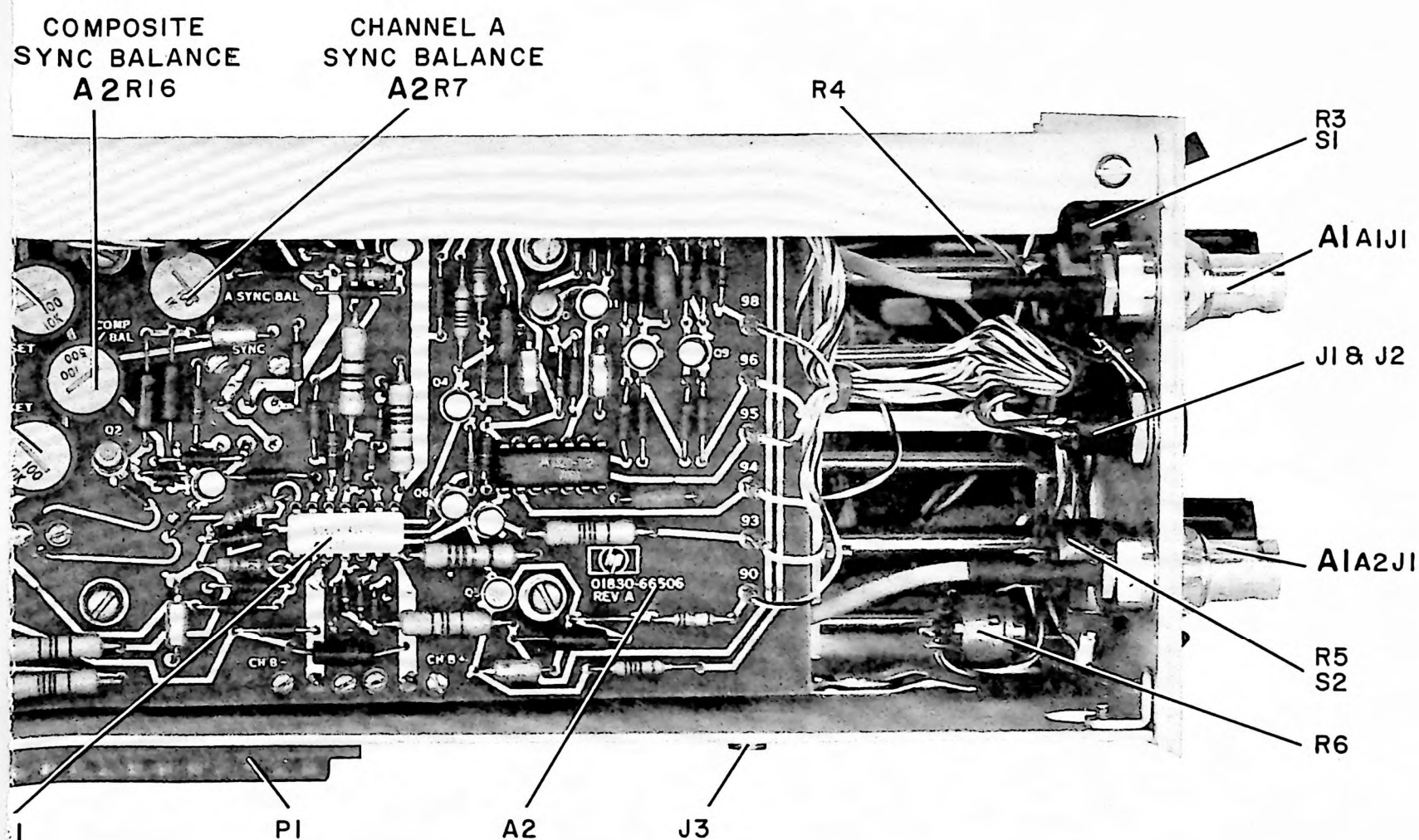
Unless otherwise indicated:
 resistance in ohms
 capacitance in picofarads
 inductance in microhenries

Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

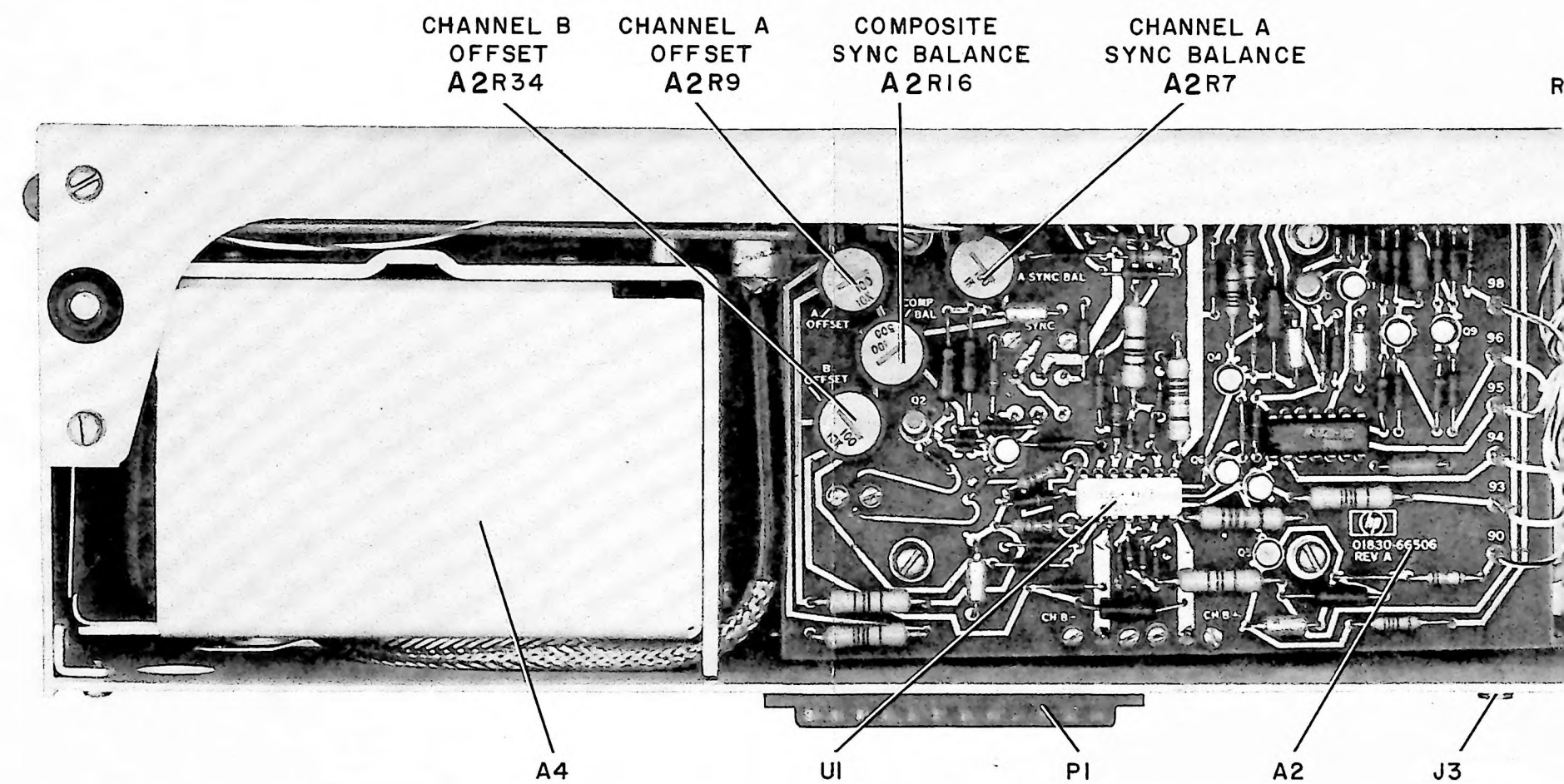
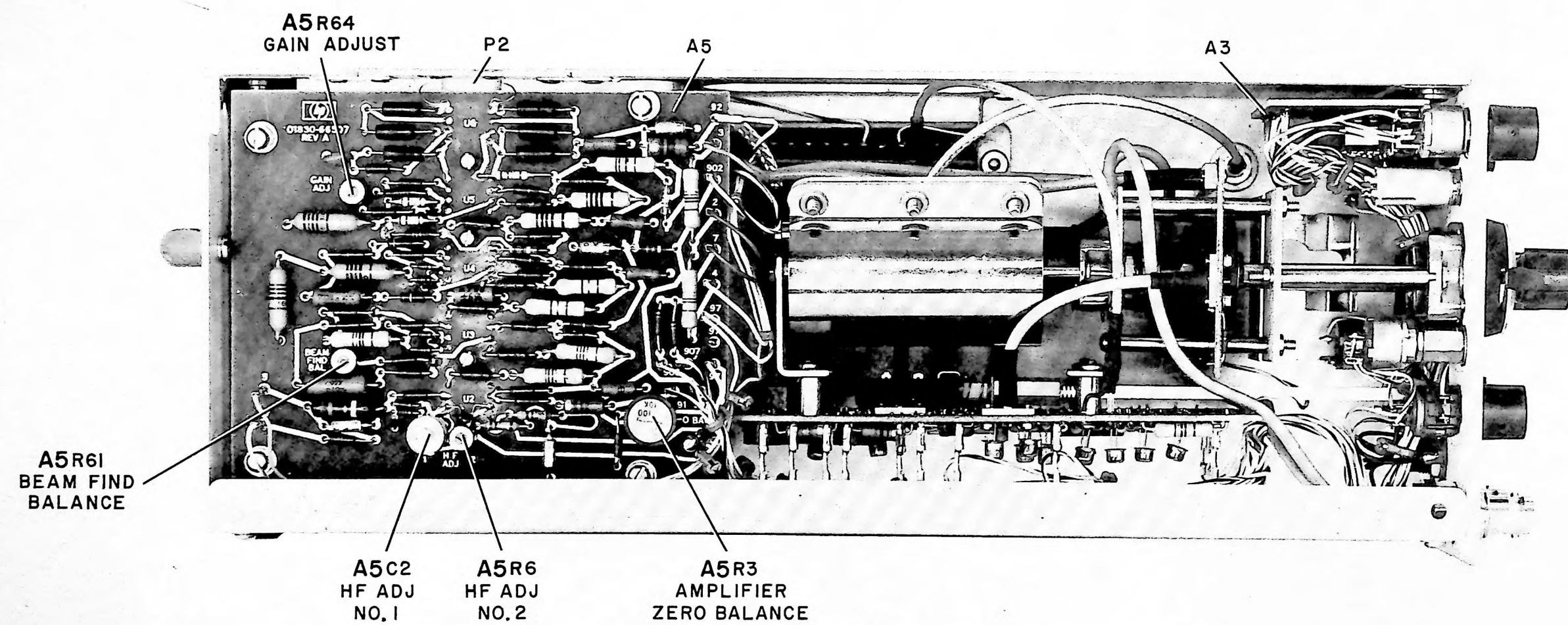
Switch wafers are identified as follows:

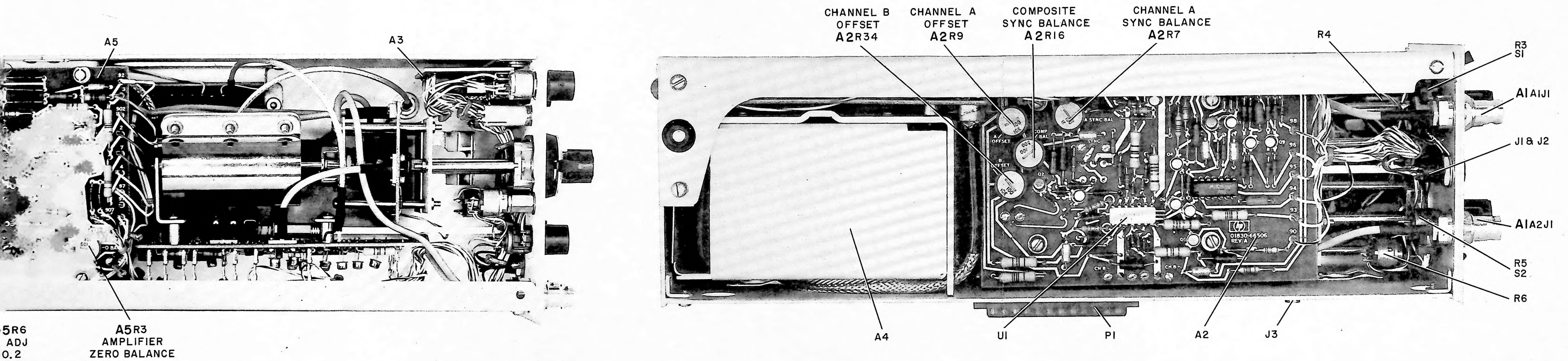




1830A-C-5A

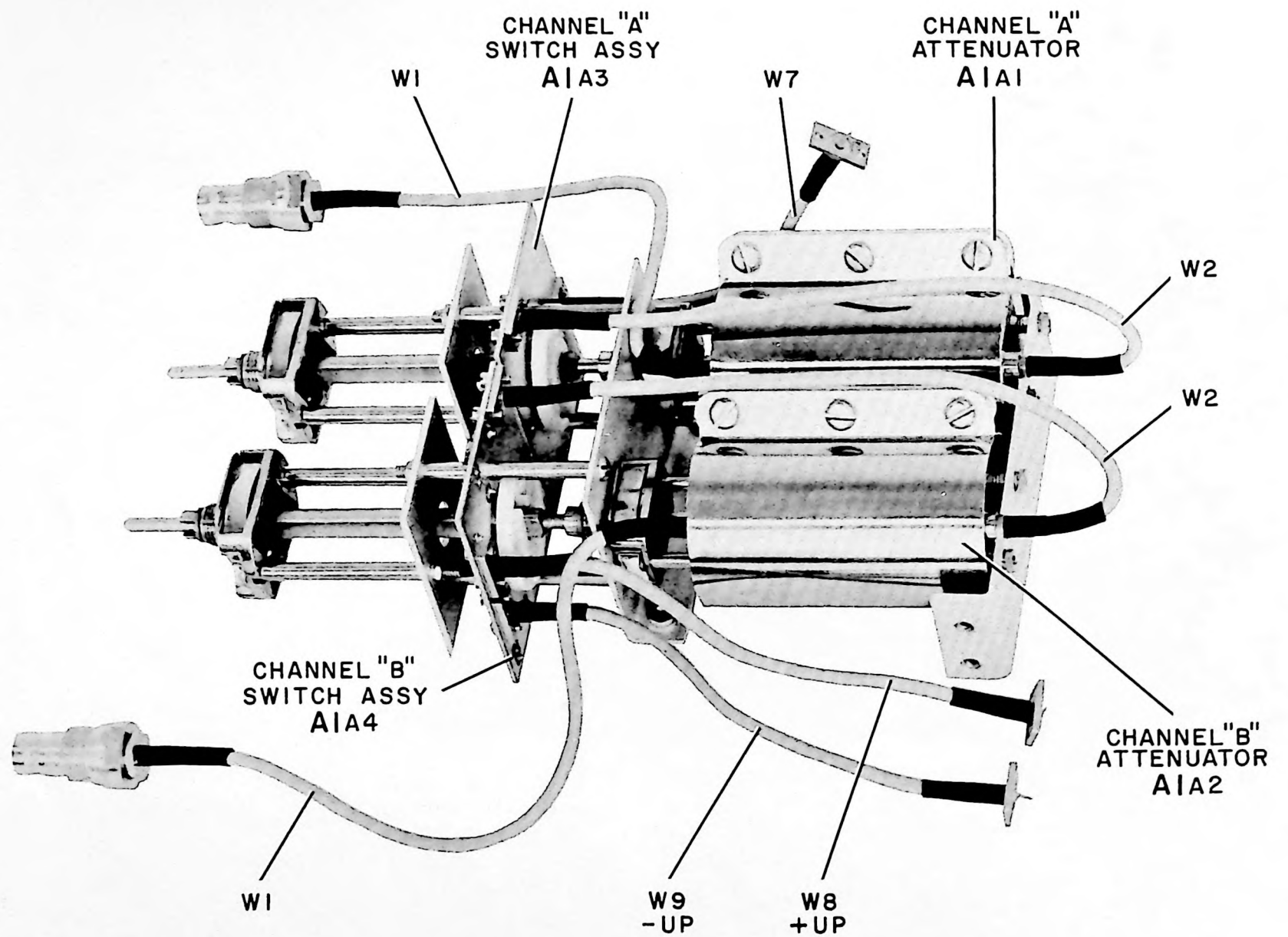
Figure 8-2.
Adjustment Location
8-7





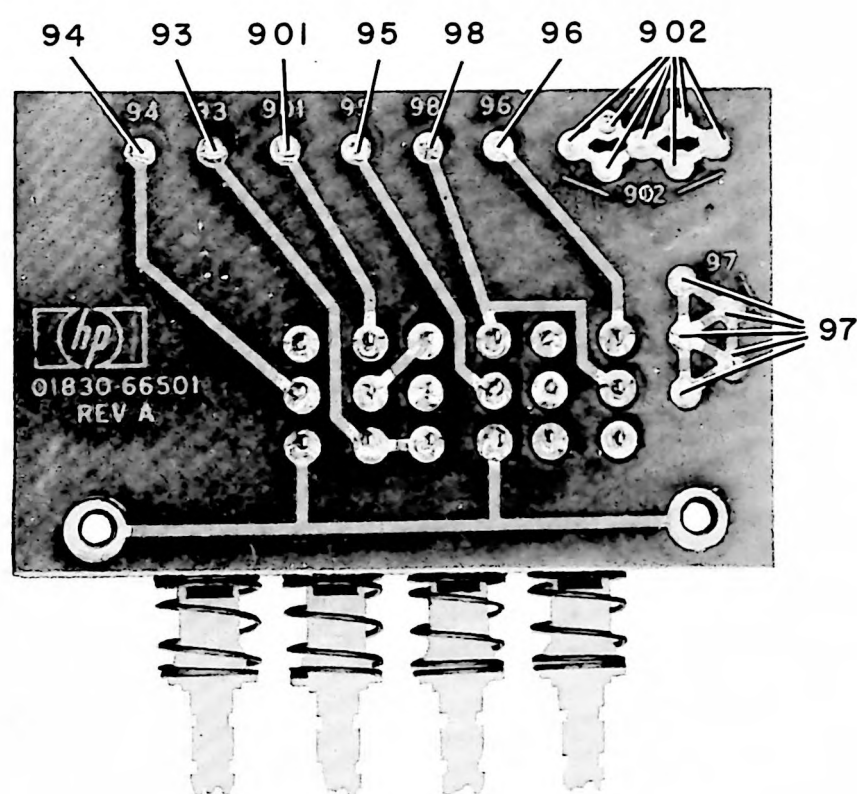
1830A-C-5A

Figure 8-2.
Adjustment Location
8-7



1830A-A-9

Figure 8-3. Signal Conditioning Assembly, A1



A3

1830A-A-18

Figure 8-4. Display Switch, A3

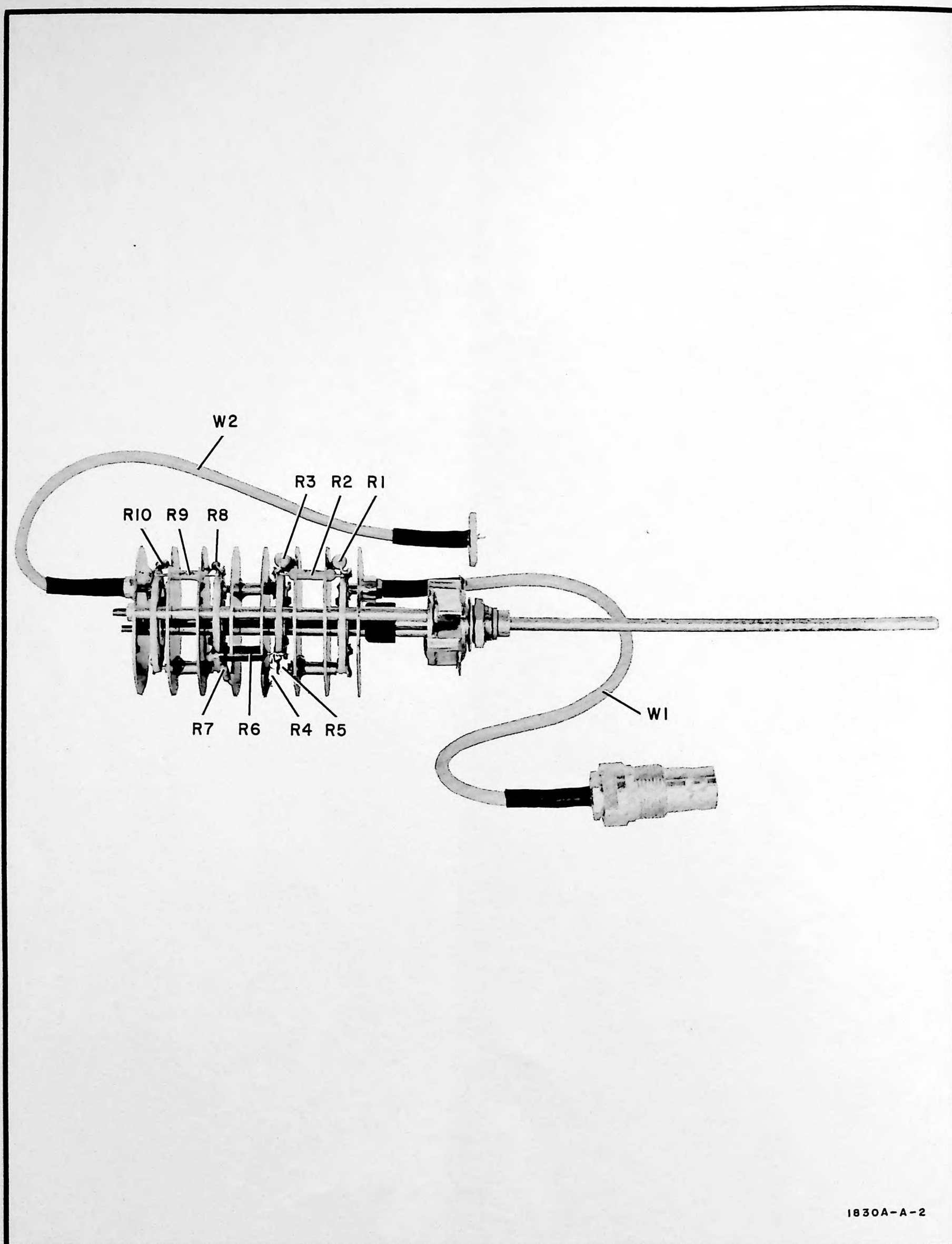


Figure 8-5. Component Identification, Attenuators A1A1 and A1A2

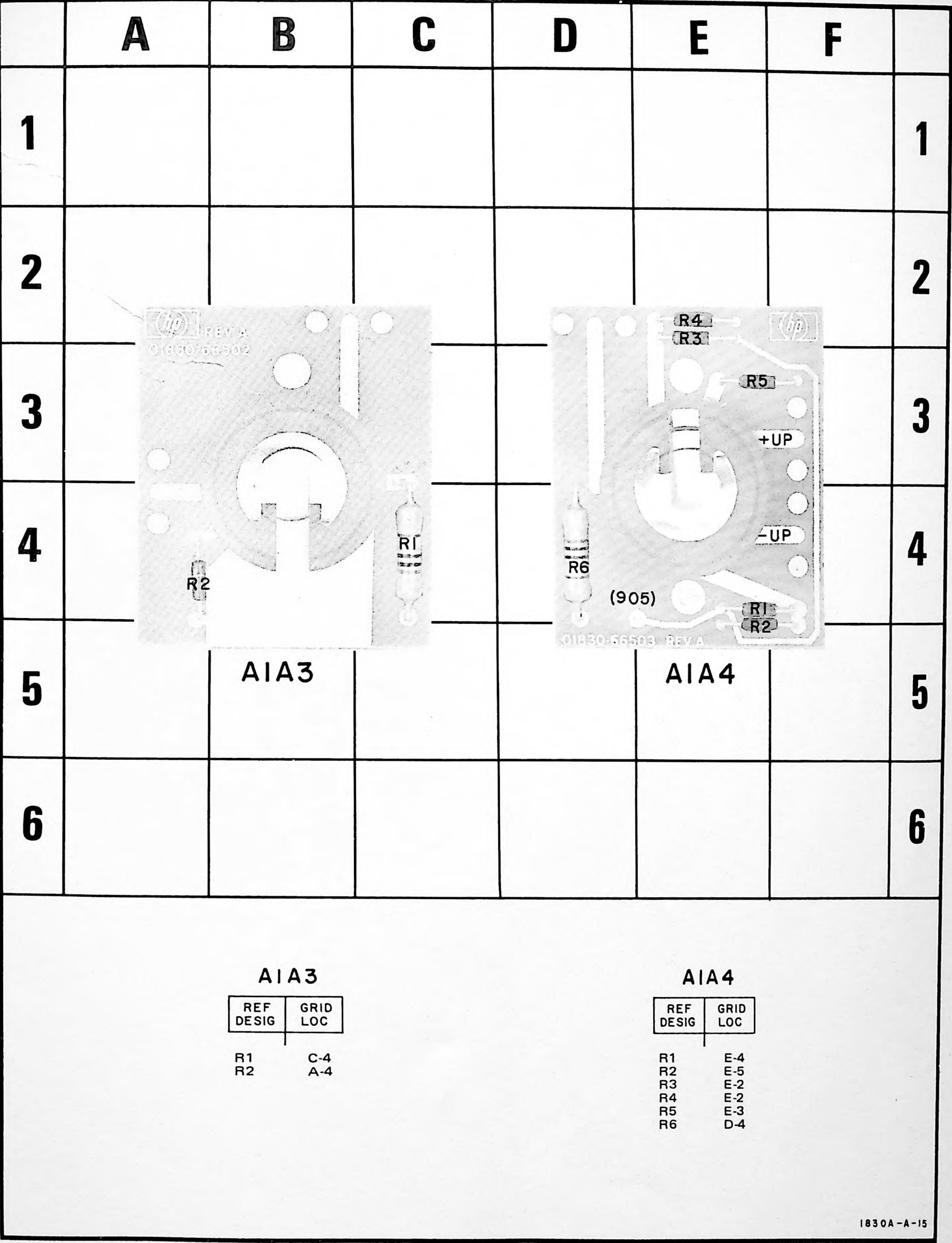


Figure 8-6. Component Identification , Input Switches A1A3 and A1A4

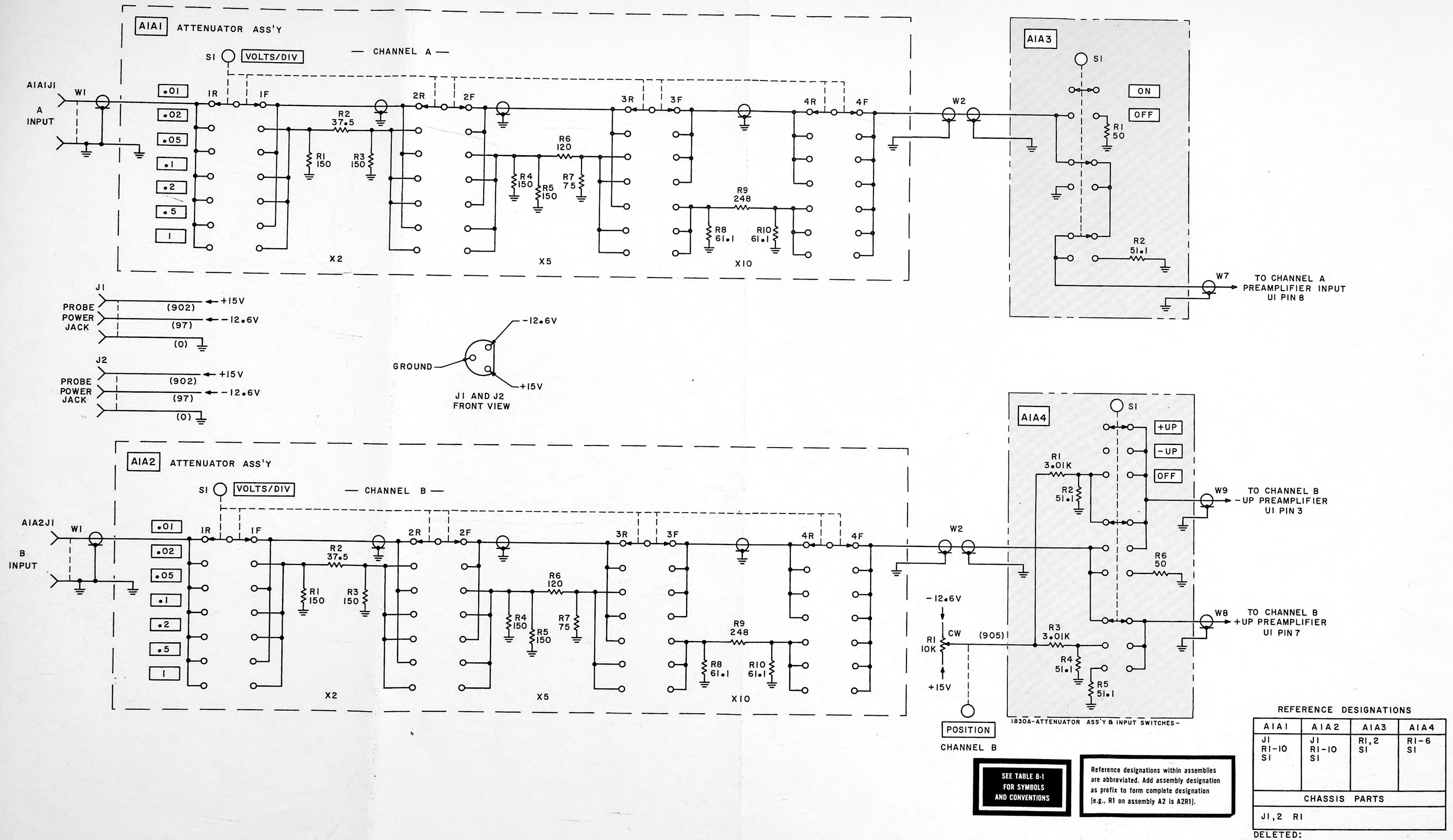
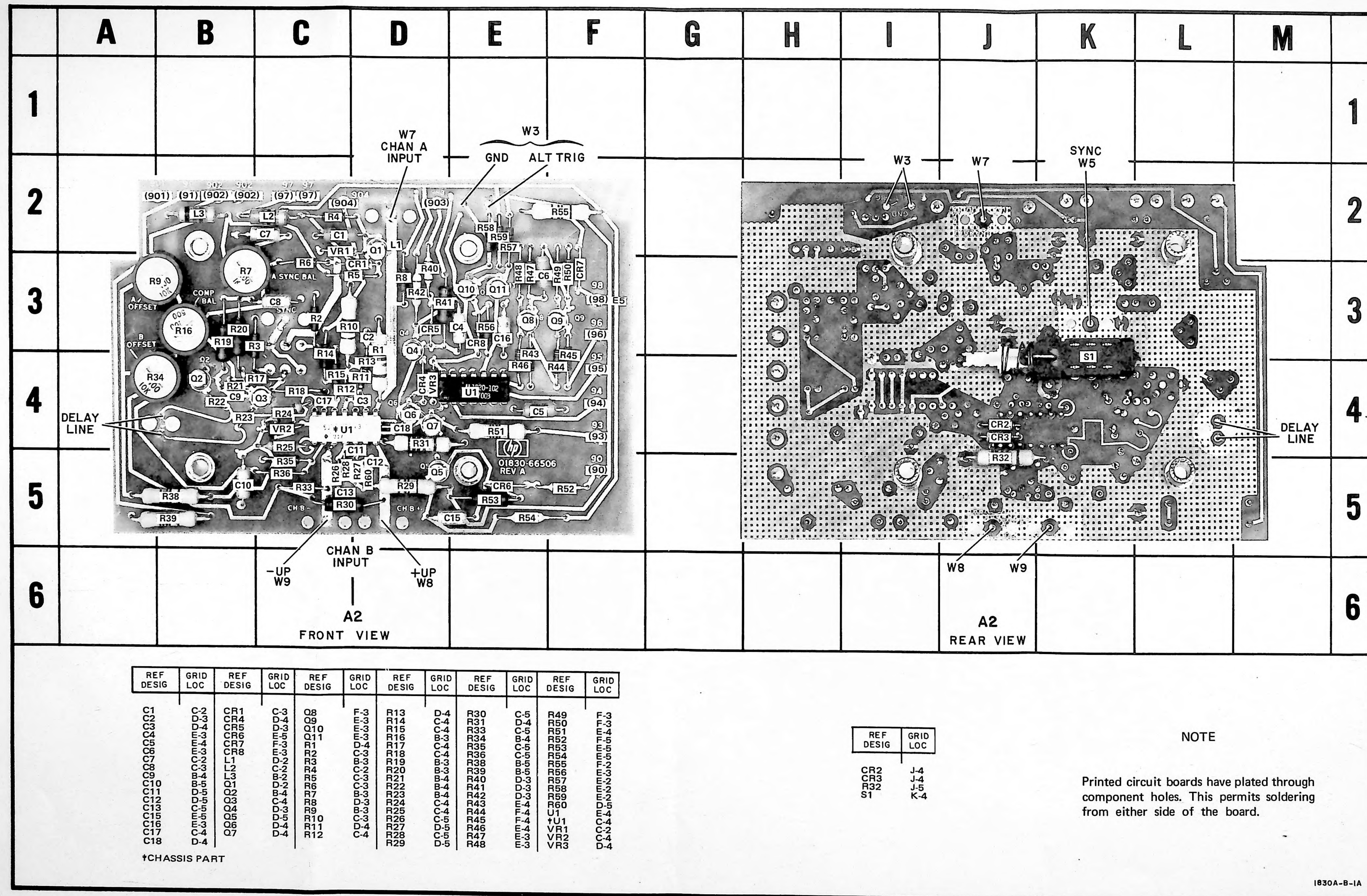


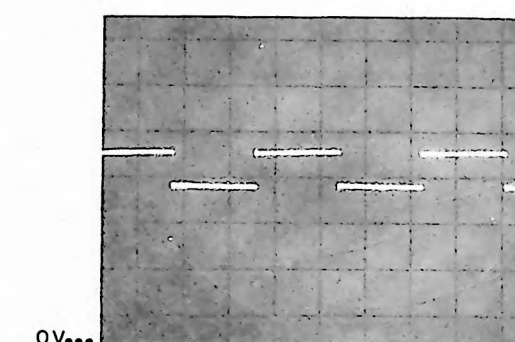
Figure 8-7
Attenuator and Input Switches, Schematic
8-9



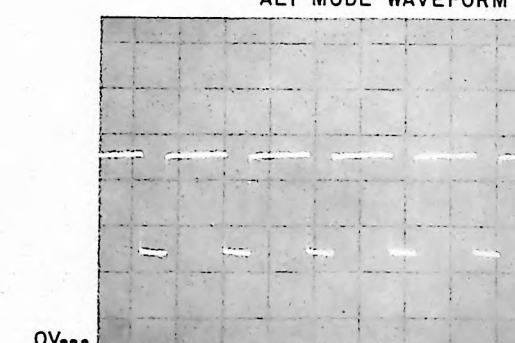
PIN NO.	ALT	A
1		+3.5
2	0	+4.8
3	—	—
4	—	—
5		
6	0	0
7	—	—
8	—	—
9	0	0
10		
11	—	—
12	0	0
13		+4.5
14	+5.1	+5.1

Note: PINS 3, 4, 7 and 8
circuit assembly ground plane.

▽ See Waveform photos.



20USEC/DIV, 1 VOLT/DIV
A2U1, PIN 1 OR 13
ALT MODE WAVEFORM



3 20 USEC/DIV, 1 VOLT/DIV
A2U1, PIN 5 OR 10
WAVEFORM FOR ALL DISPLAYS

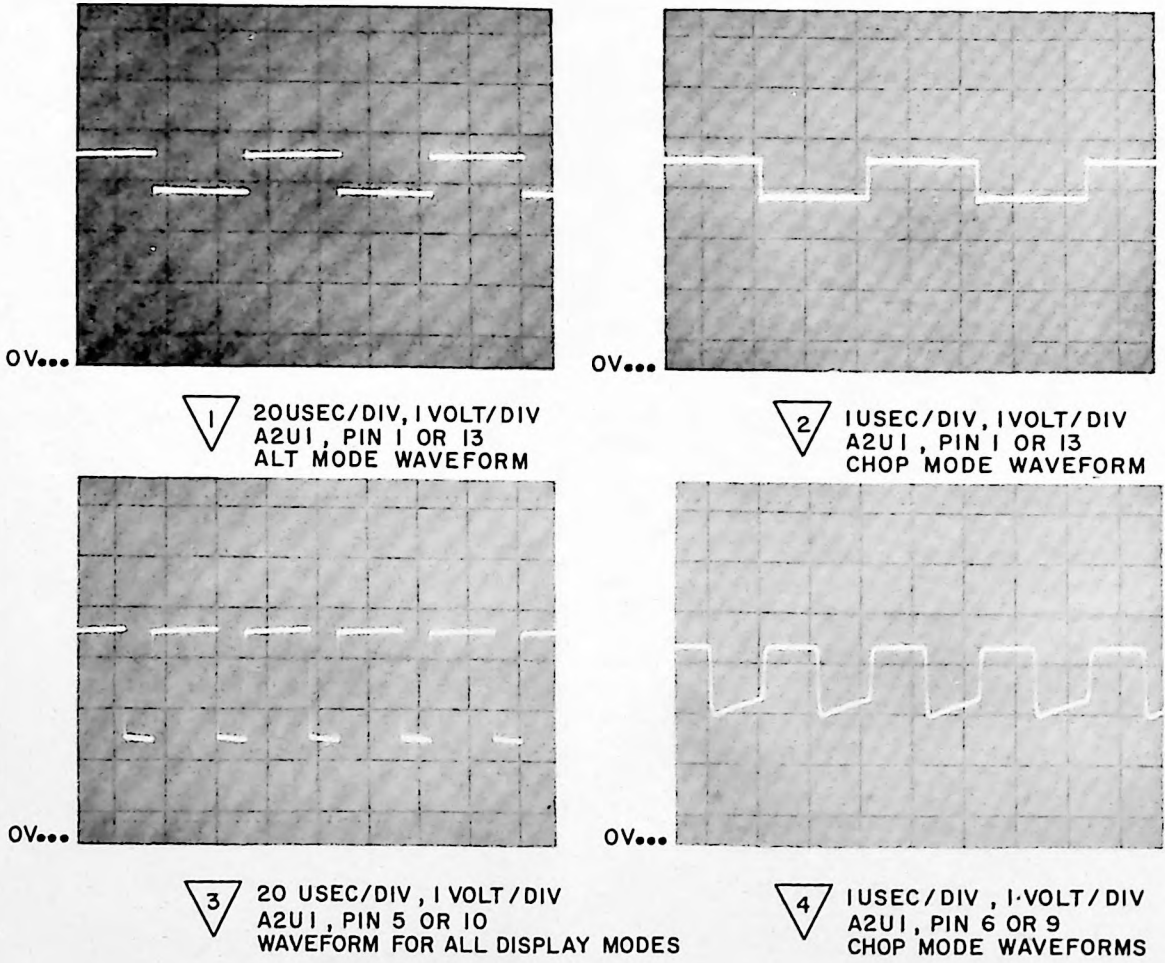
Figure 8-8. Component Identification A2

Figure 8-9. Waveforms

PIN NO.	DISPLAY MODE				
	ALT	A	B	CHOP	A+B
1	▽1	+3.5	+4.5	▽2	+4
2	0	+4.8	0	0	+4.8
3	—	—	—	—	—
4	—	—	—	—	—
5	▽3	▽3	▽3	▽3	▽3
6	0	0	0	▽4	0
7	—	—	—	—	—
8	—	—	—	—	—
9	0	0	0	▽4	0
10	▽3	▽3	▽3	▽3	▽3
11	—	—	—	—	—
12	0	0	+4.8	0	+4.8
13	▽1	+4.5	+3.5	▽2	+4
14	+5.1	+5.1	+5.1	+5.1	+5.1

Note: PINS 3, 4, 7 and 8 are connected to etched circuit assembly ground plane.

▽ See Waveform photos.



1830A-A-11

Figure 8-9. Waveforms and DC Voltages A2U1

PREAMPLIFIER SCHEMATIC

VOLTAGE MEASUREMENT CONDITIONS

DISPLAY A
 SYNC CH A
 VOLTS/DIV OFF
 VERNIER, A & B CAL

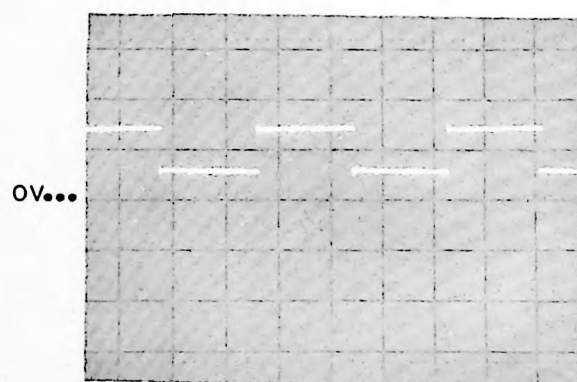
Center trace vertically or set POSITION controls at mid-range position.

All voltages measured with HP Model 412A VTVM.

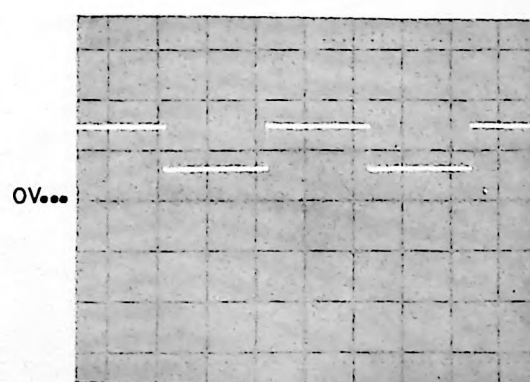
PIN NO.	DISPLAY MODE				
	ALT	A	B	CHOP	A+B
1	+3.0	+3.0	+3.0	+3.0	+2.6
2	-2.0	-2.0	-2.0	-2.0	-2.0
3	*0	*0	*0	*0	*0
4	-0.8	-0.8	-0.8	-0.8	-0.8
5	▽1	+1.5	+0.5	▽2	+0.5
6	-0.8	-0.8	-0.8	-0.8	-0.8
7	*0	*0	*0	*0	*0
8	0	0	0	0	0
9	-0.8	-0.8	-0.8	-0.8	-0.8
10	▽1	+0.5	+1.5	▽2	+0.5
11	-0.8	-0.8	-0.8	-0.8	-0.8
12	*0	*0	*0	*0	*0
13	+0.7	+0.7	+0.7	+0.7	+0.7
14	+3.0	+3.0	+3.0	+3.0	+2.6

*Note: The voltage on Pins 3, 7 and 12 is normally 0, and varies from -0.1V to +0.1V with setting of POSITION control.

▽ See waveform photos.



1 20 USEC/DIV, 1 VOLT/DIV
UI, PIN 5 OR 10
ALT MODE WAVEFORM



2 1 USEC/DIV, 1 VOLT/DIV
UI, PIN 5 OR 10
CHOP MODE WAVEFORM

1830A-A-10

Figure 8-10. Waveforms and DC Voltages, U1

CHEMATIC

NT CONDITIONS

..... A
..... CH A
..... OFF
..... CAL

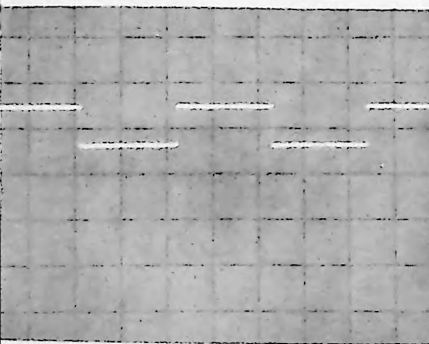
OSITION controls at mid-

HP Model 412A VTVM.

AY MODE

B	CHOP	A+B
+3.0	+3.0	+2.6
-2.0	-2.0	-2.0
*0	*0	*0
-0.8	-0.8	-0.8
+0.5	▽	+0.5
-0.8	▽	-0.8
*0	*0	*0
0	0	0
-0.8	-0.8	-0.8
+1.5	▽	+0.5
-0.8	-0.8	-0.8
*0	*0	*0
+0.7	+0.7	+0.7
+3.0	+3.0	+2.6

d 12 is normally 0, and
h setting of POSITION



2 1USEC/DIV, 1 VOLT/DIV
U1, PIN 5 OR 10
CHOP MODE WAVEFORM

1830A-A-10

nd DC Voltages, U1

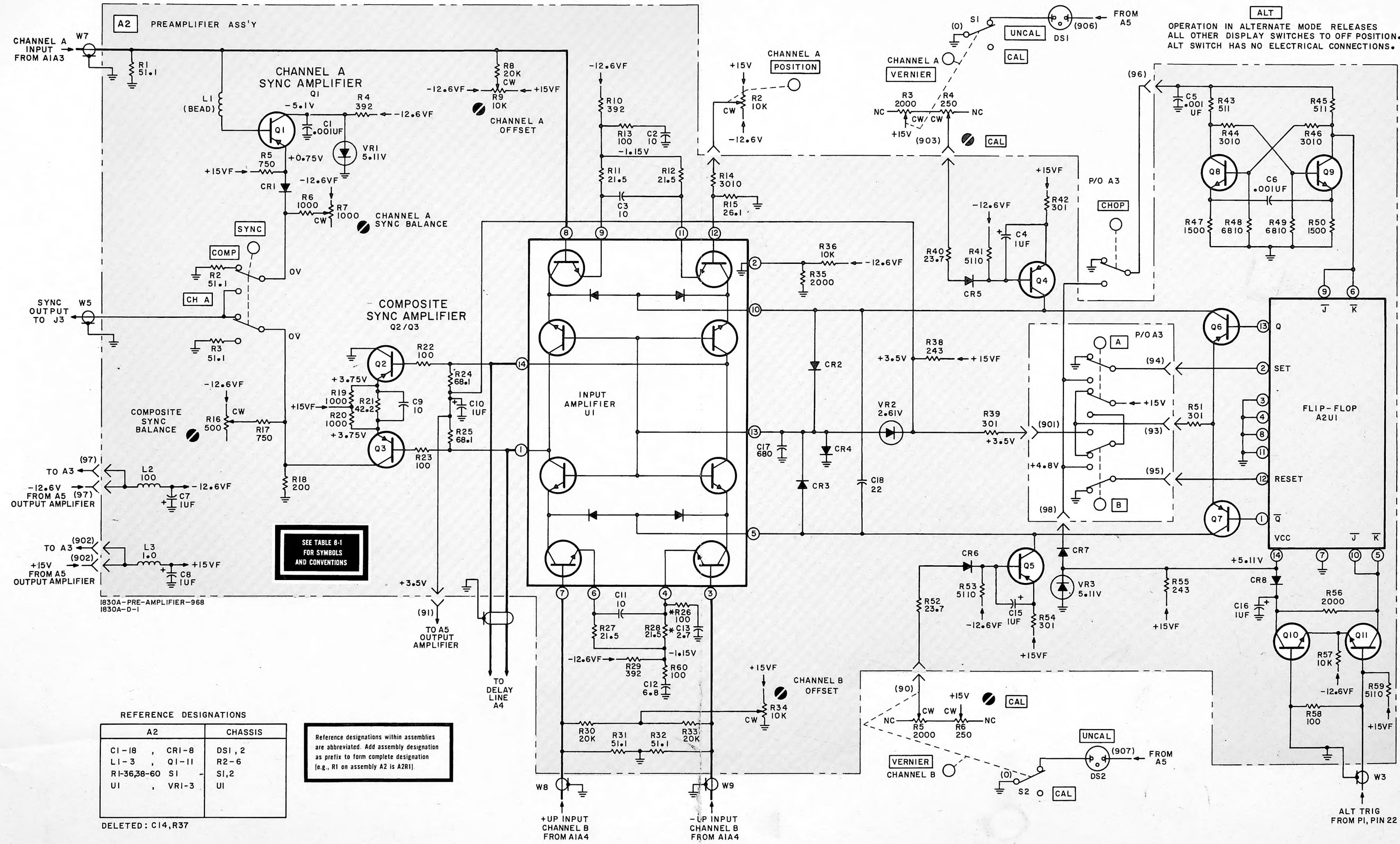


Figure 8-11
Preamplifier A2, Schematic
8-11

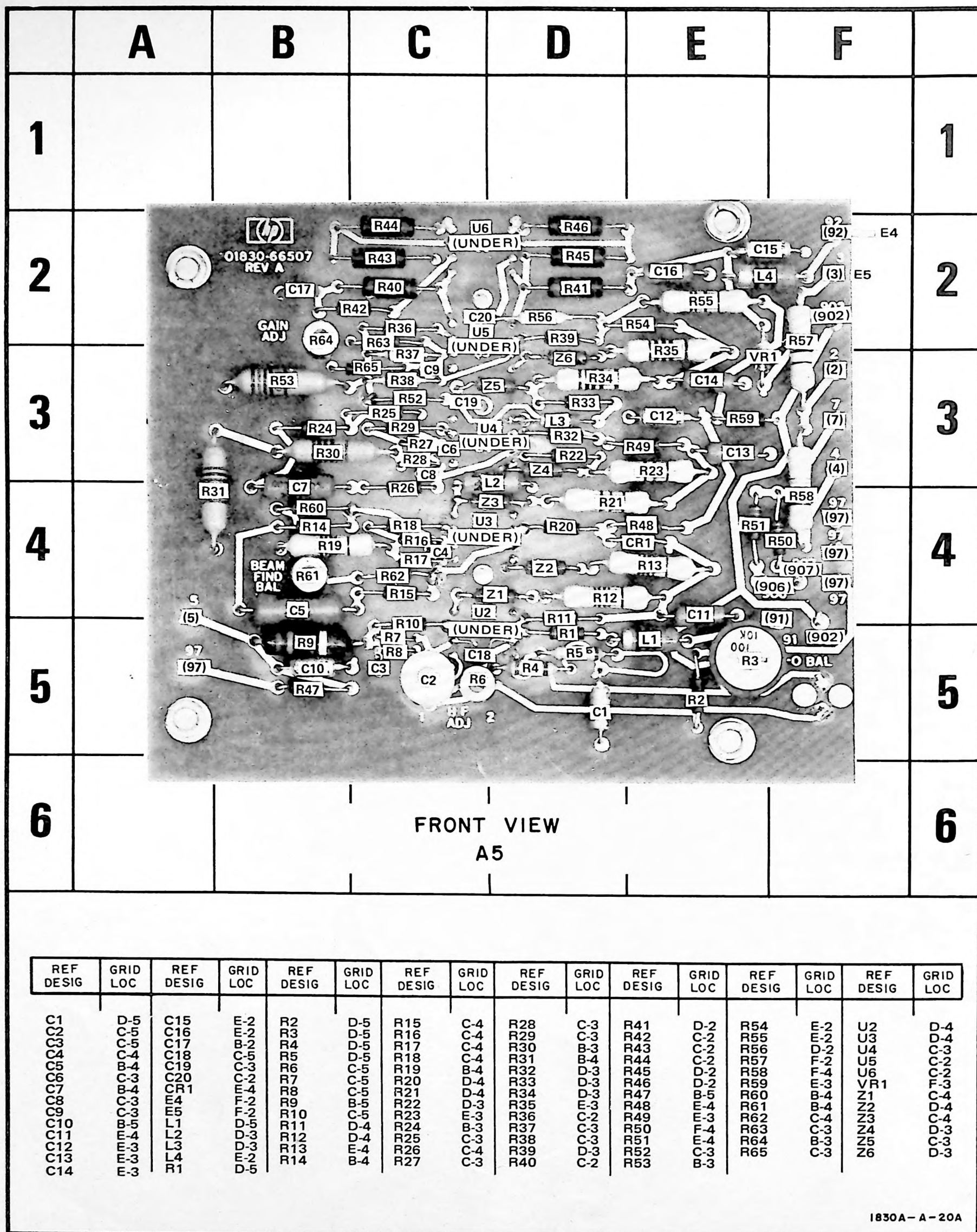
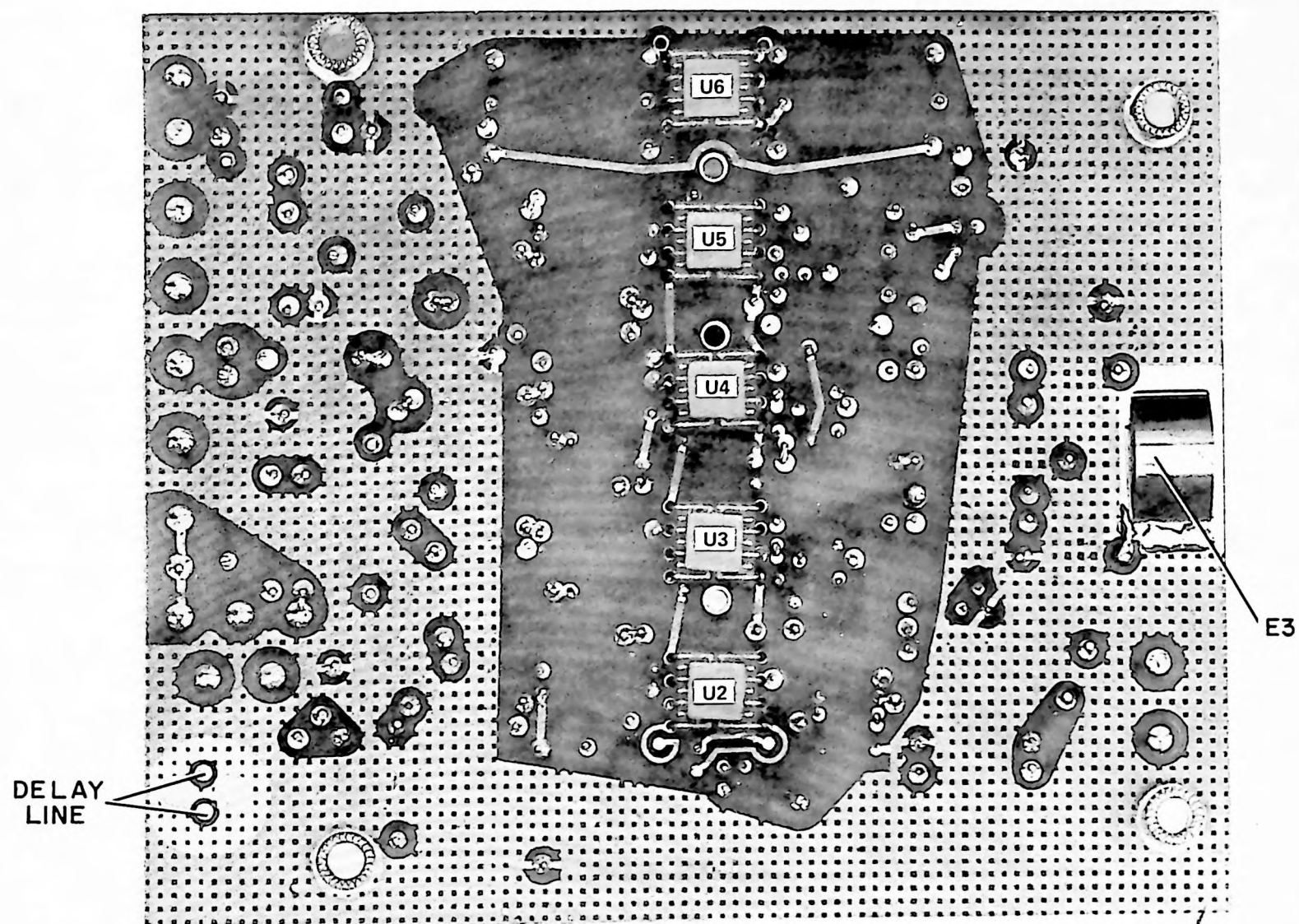
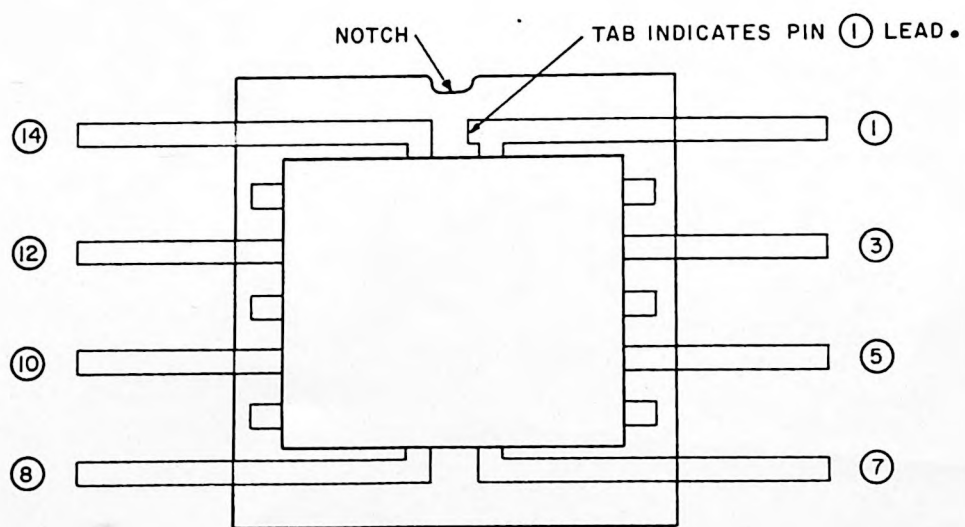


Figure 8-12. Component Identification, A5 (Front)



REAR VIEW
A5

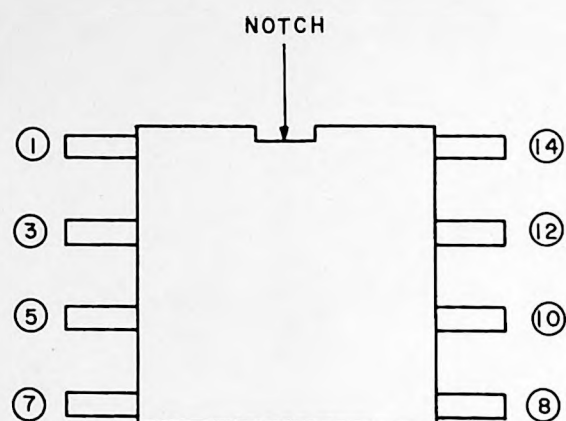


DETAILED REAR VIEW OF
U2, U3, U4, U5 AND U6

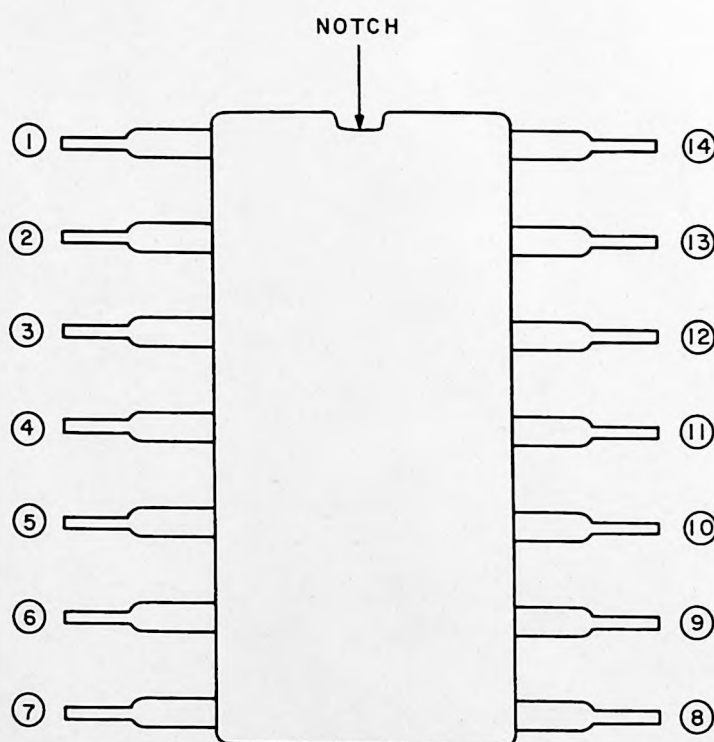
1830A-A-16

1830A-A-19A

Figure 8-13. Component Identification, A5 (Rear)



PIN CONNECTIONS
FOR
U2, U3, U4, U5, U6



PIN CONNECTIONS
FOR
U1 AND A2U1

NOTE

PIN CONNECTIONS ARE SHOWN AS VIEWED
FROM EXPOSED SIDE OF PRINTED CIRCUIT
ASSEMBLY WHEN INSTALLED IN INSTRUMENT.

1830A-C-4

Figure 8-14. Integrated Circuit Pin Identification

OUTPUT AMPLIFIER SCHEMATIC

DC VOLTAGE MEASUREMENT CONDITIONS

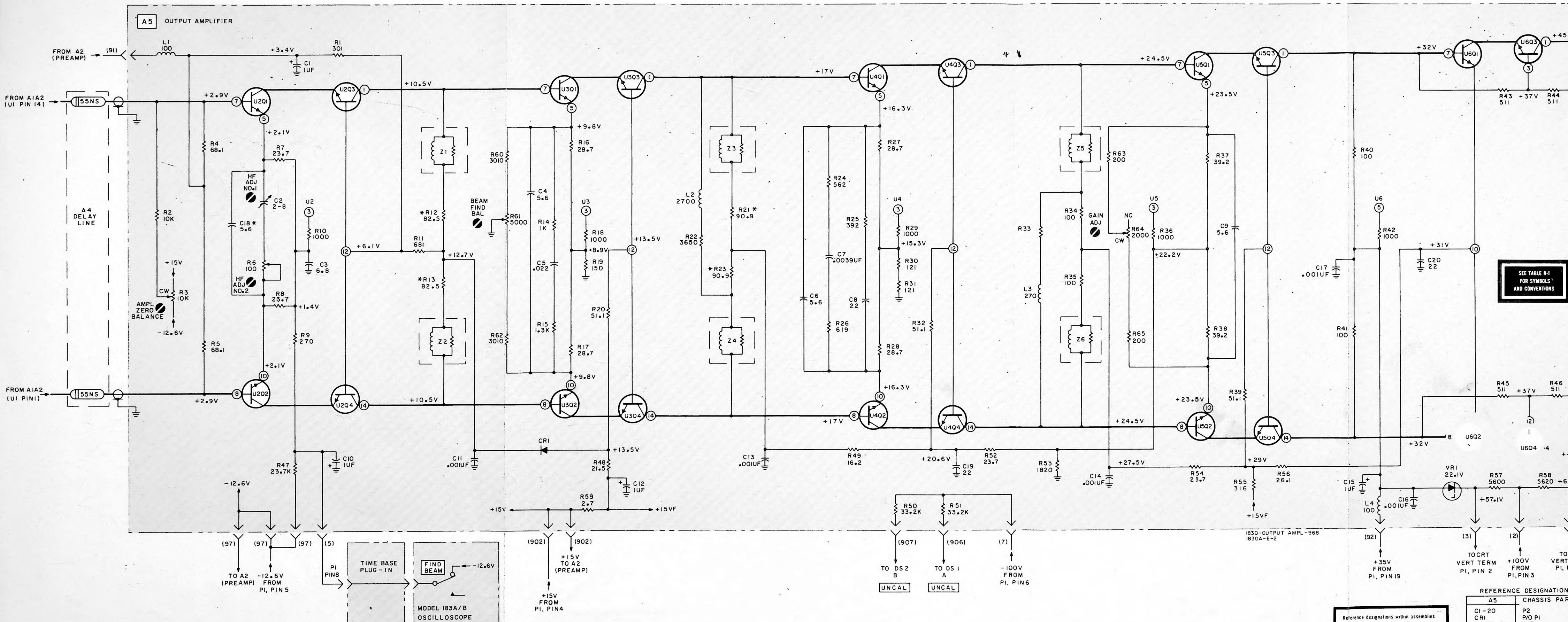
DISPLAY	A
SYNC	CH A
VOLTS/DIV	OFF
VERNIER, A & B	CAL

Center trace vertically or set POSITION controls at mid-range position.

All voltages measured with HP Model 412A VTVM.

NOTE

Printed circuit boards have plated through component holes. This permits soldering from either side of the board.



SEE TABLE 8-1
FOR SYMBOLS
AND CONVENTIONS

Reference designations within assemblies
are abbreviated. Add assembly designation
as prefix to form complete designation
e.g. R1 on assembly A2 is A2R1

REFERENCE DESIGNATION	
A5	CHASSIS PARTS
C1-20	P2
CRI	P/O PI
L1-4	WIO
R1-65	
U2-6	
VRI	
Z1-6	

DELETED:

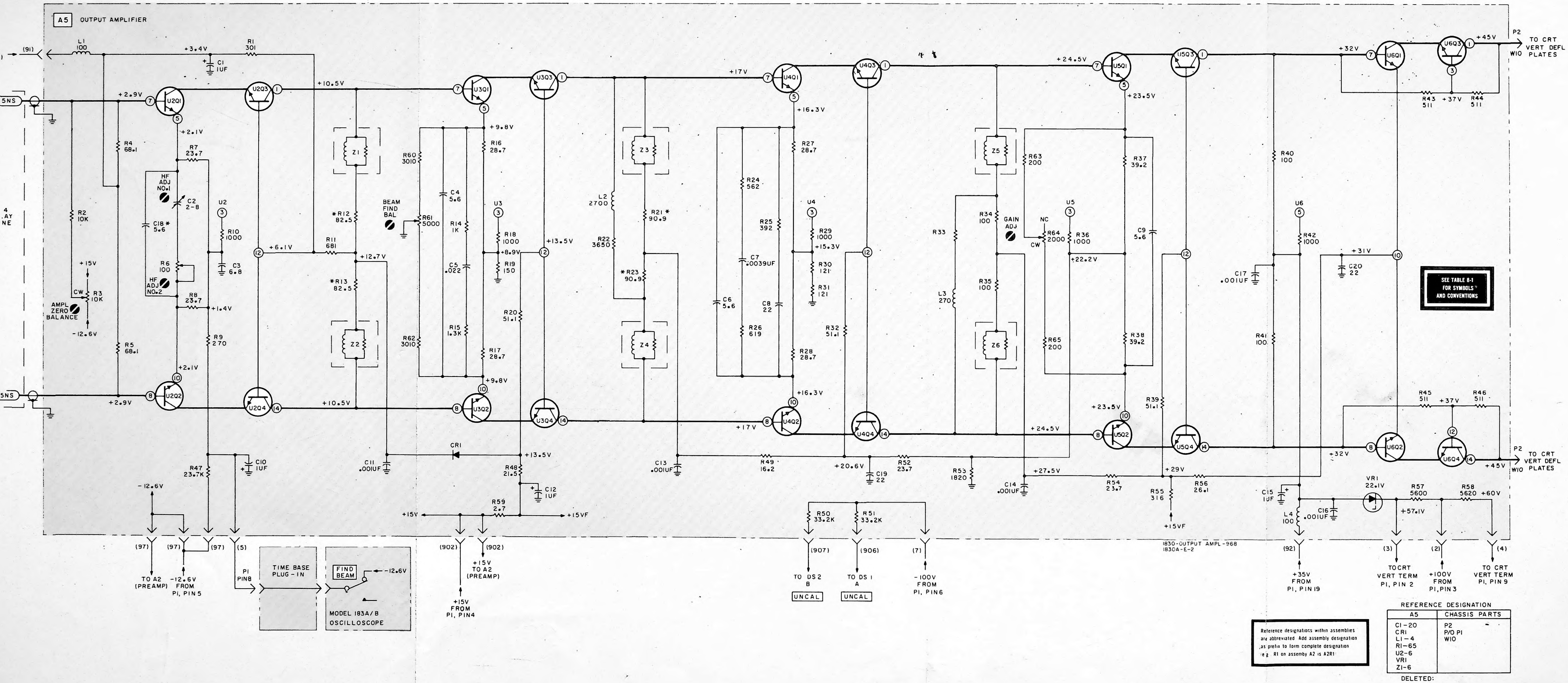
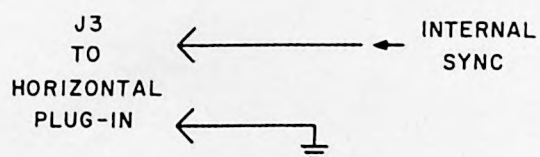
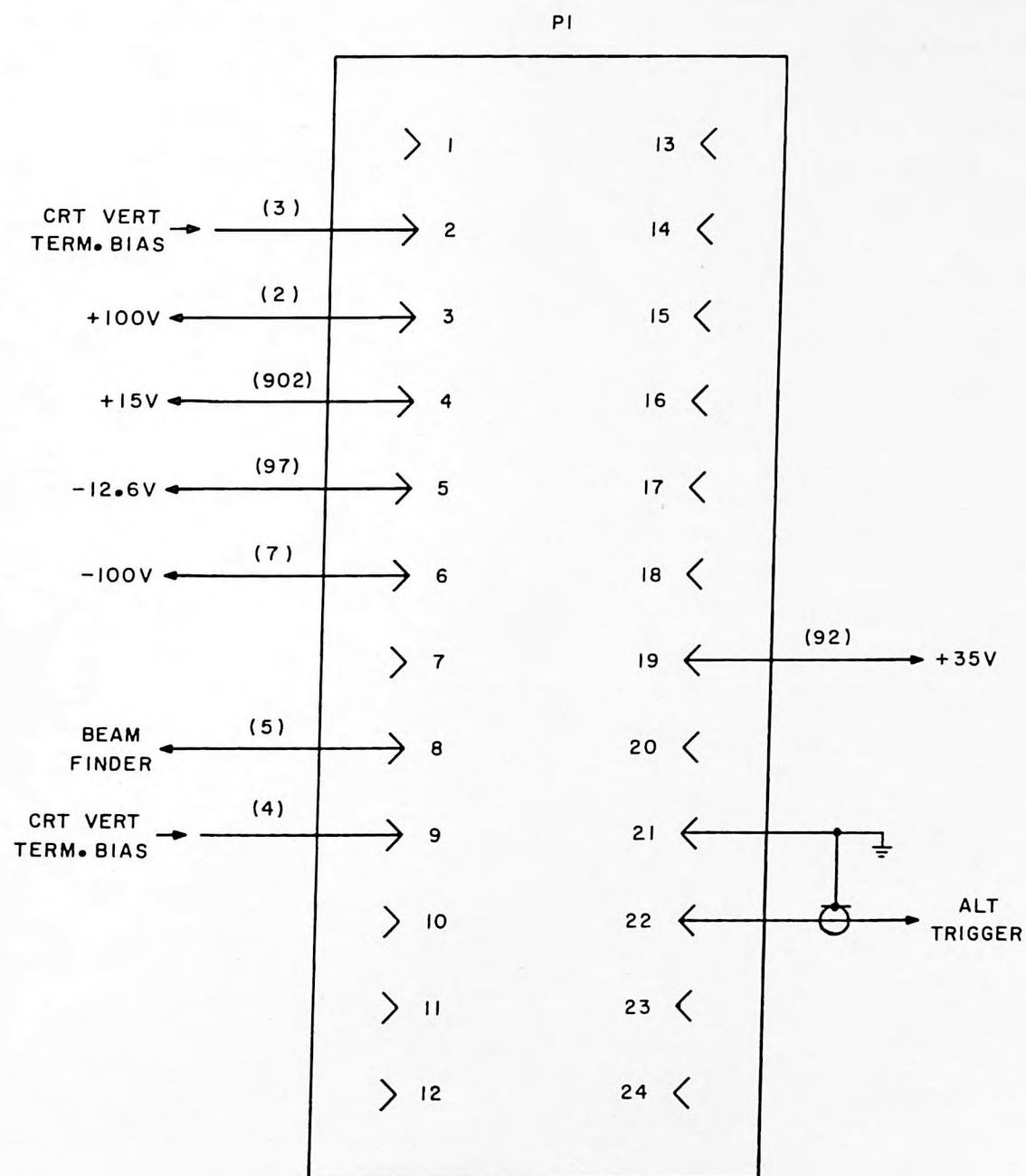


Figure 8-15.
Output Amplifier A5, Schematic
8-13/8-14



1830A-C-2

Figure 8-16. Plug and Jack Connections

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